COLLECTION OF RESEARCH SEEDS 2018

National Institute of Technology
Sendai College

COLLECTION OF RESEARCH SEEDS 2018
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PREFACE

It is our great pleasure to present this Collection of Research Seeds of Sendai College. The college, belonging to the National Institute of Technology, has a unique education system with a five-year regular course and a two-year advanced course. All students in both regular and advanced courses pursue research projects in fields of science and engineering. Advanced course students are particularly engaged in studies of advanced research topics such as information technology, telecommunications, electronics, robotics, materials and environmental science, mechanical engineering, power engineering, and architectural design.

Supervising our students, Sendai College has nearly a hundred professors who hold doctorates in fields of science and engineering. Professors giving lectures in the humanities and social sciences also hold master or doctor degrees in their appropriate fields. Consequently, these professors have their own specialized research fields: some work in support of progressive industries; some work in the front line of science and engineering writing research papers in international journals; some work to improve engineering education. It is noteworthy that about 26% of the professors of our college obtain Grants-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology. Furthermore, about 22% of professors are engaged in joint studies with other organizations: companies and industry groups, research institutions, and universities.

We believe that this booklet "Collection of Research Seeds" presents our staff's abilities and potential. You may find an exact match between your interest and a staff member's seed. Although one's research field is slightly different from your demands, you may find a good research partner on this list. We would be happy if this booklet could be of some help to people working in companies and industry groups, research institutes, and universities, and seeking international collaboration. We look forward to receiving contact from you.

Sincerely Yours,

Dr. Hiroshi FUKUMURA
President
National Institute of Technology, Sendai College

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Hirose Campus

Interdisciplinary Physics Research Based on Quantum Information Theory

Hiroaki MATSUEDA

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Affiliated Societies	Japan Physical Society, American Physical Society, High-Tc Forum
Keywords	Statistical physics (13010), Fundamental theory of condensed matter physics (13010), Mathematical physics (13010), Quantum information physics (13010), Magnetism (13030), Strongly correlated electron systems (13030), Superconductivity (13030), Quantum fluids and solids (13030)

Research Topics

・Reconstruction of renormalization group theory by singular value decomposition
・Information-geometrical analysis of gauge/gravity correspondence
・Tensor network approach to various physical problems
・Composite operator approach to strongly correlated electron systems

Research Seeds

(1) ***Interdisciplinary physics research based on quantum information theory***

In recent years, information-theory-oriented approaches have become quite powerful at forecasting common mathematical structures inherent in many branches of theoretical physics. Based on this fascinating concept, I am working on various problems, particularly addressing the quantum/classical correspondence in terms of quantum data storage into curved memory space. I am also interested in singular value decomposition and its application to statistical physics. To proceed with research efficiently, I am corroborating with many researchers within and beyond Japan. I am also proceeding to publish specialized textbooks in addition to original research papers.

(2) ***Composite operator approach to strongly correlated electron systems***

Magnetism and superconductivity are two major research topics in condensed matter physics. These phenomena sometimes originate from strong electron correlation, which drastically changes non-interacting band dispersion of electrons. We analyze the deformed band structure in terms of the composite operator approach, which can detect how electrons are dressed with non-local magnetic fluctuation. The detection naturally elucidates the understanding of the mechanism of nontrivial magnetism and high-Tc superconductivity.

Related Technology

・super-parallel computation techniques realized in K computer
・lecture of information physics based on my textbook

Nonlinear Properties of Magnetic Materials

Takashi SHIRANE

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Affiliated Societies	The Physical Society of Japan, The Institute of Electrical Engineers of Japan, The IEEE Magnetics Society, The IEEE Instrumentation and Measurement Society.
Keywords	Applied physical properties-related (29010), Applied condensed matter physics-related (29030)

Research Topics

・Measurement of linear and nonlinear susceptibilities, and magnetization curve
・Data analysis and parameter identification based on hysteresis models
・Monte Carlo simulation of magnetic lattice system

Research Seeds

●Hysteresis Measurement by Lock-in Amplifier

Figure 1 shows a schematic of the measurement system. The system includes a Lock-in amplifier (LIA), a function generator (FG), a bipolar power supply (BPS), and a personal computer. To supply an AC current to the primary coil, the BPS is driven by the FG. The BPS also provides a reference signal to LIA by shunt resistance. By connecting the signal output from the secondary coil to the LIA, we measure the in-phase component V'_{n-1} and the out-of phase component V''_{n-1} of the fundamental and harmonics of the output voltage V. Both V'_{n-1} and V''_{n-1} are measured sequentially using a harmonic detection function of the LIA. Then a BH loop can be reconstructed from V'_{n-1} and V''_{n-1} by inverse Fourier transform. Figure 2 shows minor asymmetric BH loops measured at various field amplitudes. Because the LIA can extract a signal with a known carrier wave from an extremely noisy environment, this system is suitable for measuring BH loops of micro-magnets.
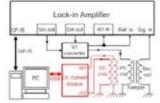
Fig. 1. Schematic of measurement.
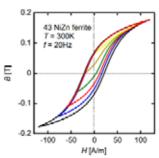
Fig. 2. Asymmetric BH loops.

●Research on Halbach-type Spin System

We have studied the feasibility and specific properties of a new type spin system , which is analogous to the Halbach array of ferromagnets, using Monte Carlo simulation.

ハルバッハ型スピン系

Fig. 3. Halbach-type spin.
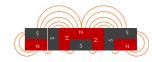
Fig. 4. Halbach array.

Related Technology

・Numerical Analysis
・Instrumentation and Measurement
・Research on Phase Transition and Critical Phenomena

Magneto-Optical Spectra of Composition-Spread Thin Films of Transition-Metal Oxides

Noriko HOSAKA		
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Affiliated Societies	JPS, JSAP	
Keywords	Semiconductors, optical properties of condensed matter and atomic physics-related (13020)	

Research Topics

・Magneto-optical properties of composition-spread thin films of transition-metal oxides
・Optical properties of the epitaxial thin films assessed using optical microscopy
・Investigation of thin films to innovate new functional materials
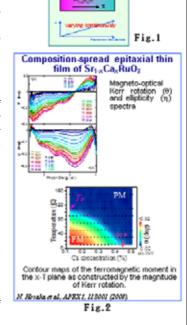
Research Seeds

Continuous estimation of magneto-optical properties of composition-spread thin films

To innovate new functional materials, the combinatorial approach with use of composition-spread films is promising because it enables coherent and systematic investigation of the properties of materials with continuously varying composition (Fig. 1).

The solid solution system of $Sr_{1-x}Ca_xRuO_3$ undergoes a change of magnetism from ferromagnetic ($SrRuO_3$) to paramagnetic ($CaRuO_3$) with doping of x despite their similar lattice and electronic structures. To investigate the magnetic criticality of $Sr_{1-x}Ca_xRuO_3$, the combinatorial synthesis of the composition (x)-spread thin film is most promising. We used magneto-optical (MO) Kerr spectroscopy employing polarization modulation to examine systematic characteristics of magnetic properties. In Fig. 2 the MO spectra of Kerr rotation (θ) and ellipticity (η) are shown for $Sr_{1-x}Ca_xRuO_3$ with varying x at 10K. Contour maps in the plane of temperature vs composition x as constructed by the magnitudes of θ at 1.71 eV are also presented in Fig. 2. The x and temperature dependence of the Kerr rotation spectra have revealed systematic and continuous change of magnetization attributable to variation of band exchange splitting. The continuous transition from the ferromagnetic to the paramagnetic state at low temperatures suggests the quantum critical point of around $x \approx 0.5$ in this epitaxial thin film sample. Our results confirm the MO technique as a useful tool for efficient and systematic investigation of the magnetic state of the combinatorially prepared materials.

Fig.1

Composition-spread epitaxial thin film of $Sr_{1-x}Ca_xRuO_3$

Magneto-optical Kerr rotation (θ) and ellipticity (η) spectra

Contour maps of the ferromagnetic moment in the x-T plane as constructed by the magnitude of Kerr rotation.

N. Hosaka et al., APEX 1, 113001 (2008)

Fig.2

[Reference] H. Koinuma and M. Kawasaki, Combinatorial Technology, Maruzen (2004) .

Related Technology

・Magneto-optical Kerr spectroscopy
・Optical microscopy

Basic Research of Photo-Generated Carrier Behavior in Semiconductors

Koji KAWASAKI

Associate Professor	kawasaki@sendai-nct.ac.jp
Affiliated Societies	The Japan Society of Applied Physics, The Institute of Electronics, Information and Communication Engineers
Keywords	Semiconductors, optical properties of condensed matter and Atomic physics-related (13020)

Research Topics

・Fundamental research on photoluminescence characteristics of ZnO crystal
・Fundamental study of carrier behavior in GaAs/AlAs superlattice
・Proposed on new quantum structure and its application to the Optoelectronic devices

Research Seeds

Wide-band-gap semiconductor materials (ZnO) and quantum confinement system of semiconductor materials have attracted considerable interest in recent years because of their various remarkable physical properties and potential applications in a number of emerging areas such as optoelectronics and photonics.

To improve device performance, it is important to ascertain the behavior of carriers in the devices. Within the devices are three processes: carrier generation, transport, and recombination. Furthermore the transport and the recombination processes are mutually competitive. Therefore, we are trying to realize the performance improvement of optoelectronic devices by clarifying the carrier behavior in semiconductors through systematic measurements of carrier luminescence and transport properties.

Fig. 1 portrays a PL measurement apparatus. PL was excited using the 325 nm line from a He-Cd laser with power of 15 mW. The samples were mounted in an optical cryostat where the temperature can be varied from 10.0 to 300 K. We are attempting to realize simultaneous observation of both light emission and transport of carriers by adding an electric field application (current detection) function to the measurement system.

Fig. 2 shows the temperature dependence of PL spectra of a ZnO single crystal. One can find from Fig. 2 that the PL spectral shape of ZnO varies complicatedly with temperature. This complicated shape change is caused by a change in the origin of luminescence with respect to temperature. Because the distribution and relaxation processes of photogenerated carriers differ from those of temperature, the PL characters of ZnO can be clarified by measuring the ZnO carrier behavior.

Fig. 1. Experi-mental Setup.
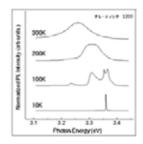
Fig. 2. The temperature dependence of PL spectra of ZnO.

Related Technology

・Optical measurement
・Improvement of LED characteristics

Raman Spectroscopy of Graphene

Kentaro SATO

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Keywords	Nanomaterials-related (28030)

Research Topics

・Optical properties of graphene
・Optical transition energy of carbon nanotubes
・Calculation of Raman spectra, electronic structure, and phonon dispersion of graphene

Research Seeds

Physical properties of few-layer graphene are affected by the number of graphene layers and their stacking structure. Resonance Raman spectroscopy has been used widely to investigate the physical properties of graphitic materials. Raman spectra provide clues to characterizing not only the graphene layer number, but also the stacking structure. We developed our computer programs to calculate the electronic structure, phonon dispersion, electron-phonon matrix elements, and electron-photon matrix elements of few-layer graphene and carbon nanotubes. Our calculated results are compared with experimentally obtained results.

Figure 1 dipicts the crystal structure of ABA-stacked and ABC-stacked trilayer graphene. We found that the stacking structure is distinguishable by M bands in the Raman spectra (Cong *et al*., ACS Nano 5, 8760). Figure 2 shows the crystal structure of twisted bilayer graphene. Since the physical properties of twisted bilayer graphene depend on the twisting angle θ_{TW}, it is important to reveal the relation between θ_{TW} and physical properties. From analysis of the Raman spectra of twisted bilayer graphene, we developed the relation between θ_{TW} and excitation laser energy for Raman spectroscopy (Ribeiro *et al*., Carbon 90, 138).
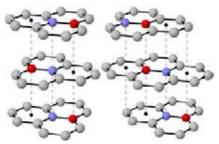
Fig. 1. Crystal structure of ABA-(left) and ABC-(right) stacked trilayer graphene.
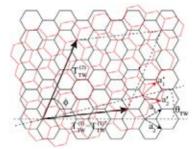
Fig. 2. Crystal structure of twisted bilayer graphene.

Related Technology

・Optoelectronic applications

Making Compact Devices Satisfying a Function

Jun SUZUKI

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Keywords	Semiconductors, optical properties of condensed matter and atomic physics-related (13020), Mechanics and mechatronics-related (20010), Electric and electronic materials-related (21050)

Research Topics

・Development of MEMS sensor
・Development of applied products using small actuators
・Research and development of micro optics

Research Seeds

Research Subject
Study to produce a compact device that satisfies a function.

Research Seeds
After miniaturizing products that satisfy a function, I undertook R&D leading to various applications such as miniaturization of an image sensor and high sensitivity image sensors, miniaturization of a medical pump, micro optics, and miniaturization of a cooling system.
My strong points are broad knowledge of development of semiconductor sensors, actuator application, mechatronics, system design, and evaluation of heat transfer.

Patents
[1] Jun Suzuki, etc. Droplet measurement system, droplet measurement method, and droplet measurement program. WO2017082381 A1, 2017-5-18.
[2] Jun Suzuki, etc. Tube pump. Japan patent JP2016-118148A, 2016-6-30.
[3] Jun Suzuki, etc. Cell culture method and cell culture device. WO2016093321 A1, 2016-6-16.
[4] Sadahisa Warashina, Jun Suzuki. Infrared image sensor and signal reading method. Japan patent JP5749534B, 2015-7-15.
[5] Fumikazu Ojima, Jun Suzuki, Ryusuke Kitaura. Thermal infrared detector. Japan patent JP5456810B, 2014-4-2.
[6] Jun Suzuki, etc. Photodetector. Japan patent JP5255873B, 2013-8-7.
[7] Jun Suzuki, etc. THz wave detector and manufacturing method. Japan patent JP2011-237312A, 2011-11-24.

References
[1] Akitomi, S., Hirose, K., Fukue, T. and Suzuki, J., "Basic Study on Discharge Flow Characteristics of Roller Tube Pump", International Journal of Engineering Research and Development, Vol. 12, No. 12 (2016), pp. 47-52.
[2] Suzuki, J., Suzuki, N., Hirose, K., and Fukue, T., "Basic Study on Effects of Dimensions on Heat Transfer Enhancement around Heating Components by Pulsating Airflow", International Journal of Engineering Research and Development, Vol. 14, No. 3 (2018), pp. 22-28.

Related Technology

・Mechanoptics
・Micro Electro Mechanical Systems

Mathematics and Physics of Topological Matter

Kazuki HASEBE

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Affiliated Societies	Japanese Physical Society
Keywords	Theoretical studies related to particle-, nuclear-, cosmic ray and astro-physics (15010)

Research Topics

・Topological insulator (Quantum Hall effect, etc.)
・Non-commutative geometry
・Topological aspects of quantum mechanics

Research Seeds

● Quantum Hall effect (topological insulator)

I am interested in the physics of topological insulators, particularly in quantum Hall effect. A quantum Hall system has bulk property of insulation, but its boundary property is metallic. Importantly, the metallic boundary current is immune to impurity scattering. Its robustness is guaranteed by topological invariant defined in the bulk.

I have been working on the relativistic quantum Hall effect in graphene and higher even-dimensional quantum Hall effect from a theoretical standpoint. Although the quantum Hall effect was originally formulated in two dimensions, we generalized it in higher even dimensions and unveiled universal formulation of the quantum Hall effect. In a modern perspective, the higher even-dimensional quantum Hall effect is classified to the topological insulator of A-class. Although the higher dimensional quantum Hall effect has been regarded merely as a hypothetical system, a modern cold atom system of optical lattice has provided an opportunity to simulate higher dimensional systems experimentally, regarding the energy spectrum as a new dimension. Future developments of higher dimensional physics are greatly anticipated.

I have also studied odd-dimensional generalization of the quantum Hall effect. Whereas a natural setup for the quantum Hall effect is even-dimensional, I have demonstrated that by regarding the odd-dimensional system as a subspace embedded in one dimension higher than an even-dimensional one, the odd-dimensional system finds its natural origin. I expect to clarify the physical properties of the odd dimensional, especially three-dimensional, quantum Hall effect in future studies. I am also interested in topological metals such as a Weyl semimetal – a three-dimensional counterpart of graphene.

● Non-commutative geometry

By dividing space-time into extremely fine pieces, it is expected that one can eventually encounter a quantum unit of space-time. Non-commutative geometry is a mathematical framework to describe the geometry comprising no-longer divisible units. I have been exploiting non-commutative geometry that effectively appears in the context of quantum Hall effect. I am particularly working on spherical non-commutative geometry realized in the magnetic field generated by a monopole. This system has a close relation to deep mathematical concepts such as the Hopf fibration and index theorem.

Related Technology

・Mathematica calculation
・Advanced mathematics such as group theory, differential geometry, and topology

Developing a Gamma-ray Detection System

Mika KAGAYA

Assistant professor	mikagaya@sendai-nct.ac.jp
Affiliated Societies	The Physical Society of Japan, Japan Society of Medical Physics, Japan Society of Mushroom Science and Biotechnology
Keywords	Experimental studies related to particle-, nuclear-, cosmic ray and astrophysics (15020)

Research Topics

・Developing a Compton camera using scintillators for measuring environments
・Developing of a radioactive inspection system for shiitake mushroom bed logs
・Developing of an electron-tracking Compton camera using SOI pixel sensor
・Origin of ultra-high-energy cosmic rays using multi-wavelength observation
・Simulation of mirror layout for a large size telescope of the Cherenkov Telescope Array

Research Seeds

①　Development of a radiation detection system (gamma eye group)

  Gamma-ray detection systems have progressed in areas of high-energy physics, gamma-ray astronomy, and nuclear medicine. Since 2011, this detection technology has been used for environmental monitoring because of the Fukushima Daiichi nuclear power plant accident. We have developed a Compton camera to visualize arrival directions of gamma rays for environmental monitoring (Kagaya et al. 2015). We measured gamma rays with an environment of a low-level contaminated area (~0.1 μSv/h) and nuclear medical facilities (Watanabe et al. 2017). Moreover, we developed a Compton camera for high-dose-rate environments and carried out measurements at the Fukushima Daiichi nuclear power plant (Katagiri et al. 2018). Furthermore, we developed a portable radioactive inspection system without a shield for shiitake mushroom bed logs (Japanese patent application No. 2017-04692). We took outdoor measurements at a low-level contaminated area to select safety bed logs (< 50 Bq/kg) using screening tests.

②Study of gamma-ray astronomy and ultra-high-energy-cosmic rays (UHECRs)

  The origin of UHECRs is an important astrophysical problem. The acceleration sites and the acceleration mechanisms of UHERCs remain unsolved since their discovery 50-60 years ago. We have investigated the possibility of acceleration of UHECRs in nearby active galactic nuclei (AGNs) using archival multi-wavelength observational data. Also, I am a member of the Cherenkov Telescope Array (CTA) project: a next generation TeV gamma-ray observatory. The Japan group has been developing the large telescope. I evaluated the weather durability of a mirror and simulated the mirror layout.

Related Technology

・Development of radiation inspection systems

Interaction between Materials and Laser Light

Kyoji KOMATSU

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Affiliated Societies	Jpn. Soc. Appl. Phys., Soc. Polym. Sci. Jpn., Chem. Soc. Jpn.
Keywords	(1) Ultrashort pulsed laser; (2) Organic materials; (3) Organic NLO materials (35030)

Research Topics

・Interaction of materials with ultrashort pulsed laser light
・Fabrication of organic nonlinear optical (NLO) crystals
・Development of a novel NLO polymer
・Fabrication of optical waveguides of organic materials

Research Seeds

  Ultrashort pulsed laser light irradiation on materials engenders the occurrence of various nonlinear optical processes and simultaneous emission of X-rays from materials. Because characteristic X-rays contain information related to elements contained in the materials, simple elemental analysis is possible. Using this method, we except to develop simple and inexpensive detection methods for elements of foods, leaves of trees, and various materials.

  Fabrication of organic nonlinear optical (NLO) crystal
Organic nonlinear optical materials, which have attracted much attention because of their superior NLO properties and ultra-fast response, are promising materials for optical information processing. Actually, DAST crystal, the most popular organic nonlinear optical crystal, is often used for electro-optical switching and terahertz generation. These research themes are the design of novel DAST derivatives and development of a method of growing single crystals with few defects.

  Developing a novel NLO polymer
Polymer materials are excellent for mass production of optical circuits because wet processing is useful for thin film fabrication. In NLO polymer materials, the NLO chromophores in the polymer are expected to have a non-centrosymmetric orientation. Therefore, the NLO chromophores that bond or disperse to the polymer are oriented by an electric field. To retain the non-centrosymmetric orientation, the polymer structure and the chromophore structure have been improved.

  Fabrication of optical waveguide of organic materials
The optical waveguide of inorganic materials is produced using a multistep process incorporating photolithography and reactive ion etching.
Fine structure fabrication technology has been developed according to the mold replication process, by which the features of solubility and plasticity of polymer were enhanced.
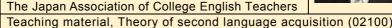
Related Technology

・Ultrashort pulsed laser beam irradiation
・Crystal growth technique for organic materials
・Synthesis of organic NLO polymers

Vocabulary Acquisition through Reading and Development of Effective Vocabulary Learning Tasks

Yoshikatsu KUBOTA

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Keywords	Teaching material, Theory of second language acquisition (02100)

Research Topics

・Vocabulary size of KOSEN students
・Effectiveness of extensive reading
・Effectiveness of reading English texts aloud

Research Seeds

・Development of Effective Vocabulary Learning Tasks

In the age of a globalized economy, KOSEN graduates are expected to play active roles as engineers with a global perspective. One important skill they need is communicative competence of English. Based on Wesche and Paribakht (2000), I developed some English vocabulary learning tasks that are useful in classrooms and measured their effectiveness. Students' responses to those tasks were positive, but further analysis must be done to evaluate tasks that support students' vocabulary learning.

During the past three years, we measured the English vocabulary size of our students, which revealed that they learned more than 300 words a year during their first three years, but their progress slowed in their 4th and 5th years. The vocabulary of half of the 4th year students shrank. Therefore, some means of developing effective vocabulary learning tasks must be found for higher grade students.
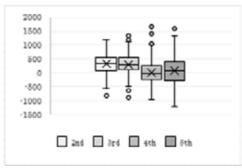
Fig. 1 Vocabulary Size Growth in a Year.

・Research on Words KOSEN Students Should Know

KOSEN students must know vocabulary used in their respective research fields such as information technology, electronics, and mechatronics. They must also earn high scores on the TOEIC ® test to demonstrate their English proficiency. The range of vocabulary they should learn is quite wide, but the amount of time they can spend studying English is limited. Therefore, for efficient study, we must elucidaate what words they should know and compile appropriate word list.

Related Technology

・How to learn English through extensive reading
・Instructions for taking the TOEIC® assessment
・How to learn English vocabulary effectively

Analyzing Concentration of Active Learning using Bio-Signals

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Keywords	Wireless measurement technology (IoT) (60060), Measurement and analysis of bio-signal (62010), Global PBL (09070), Development of educational contents (09010)

Research Topics
・Wireless bio-information measurement and analysis
・Development of multimedia educational contents and self-learning contents
・Global PBL learning contents, generic skill evaluation

Research Seeds

Research themes
· Analysis of concentration of objective learning using bio-signal
· Analysis of activation of objective learning using bio-signal
· Evaluation of practices and student skills of global PBL
· Environmental survey and analysis of students' subjective learning (development of learning tool)

Research seeds

The role of teachers is changing along with the change of learning style. As efficient learning support for students, improving the knowledge consolidation process engenders improvement of educational style not only for students but also for teachers. Knowing whether students are concentrating on classes can lead to improvement in learning efficiency. If this can be learned objectively nearly in real time, not through subjective evaluation such as questionnaire or posterior evaluation, then the lesson can be improved. Therefore, analysis is performed by measuring the skin electrical resistance (skin electrical reflection), number of blinks, head position information, electroencephalogram, and other phenomena as biological information of the student being studied. Using IoT technology, various biological information of students taking lectures in classrooms, etc., are gathered simultaneously and are analyzed by a server. Treated activity and inactivity during group work are used as big data.

Through the standard and implementation of the global PBL, a student develops planning, communication skills and plan execution ability. The PBL that is being conducted in the laboratory is a subject of engineering field, especially sequence control; the theme that the solution can evaluate concretely is the theme. We are continuing to investigate changes in generic skills not only by Japanese people in the same educational environment but also through experiences in a global environment and overseas PBL implementation.

By objective monitoring of the degree of concentration on a group basis, it can be expected to be effective for confirmation of the degree of concentration at the time of work at a factory, etc., seminars, and operation at workshops.

Related Technology
・Watch-type gaskin electrical resistance measuring device
・Simple electroencephalogram measurement system
・Sequence learning kit

Multidimensional Approach to Multi-Cultural Education and Diversity Education

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Keywords	Inclusion and cohesive society (09060), School education (09010)

Research Topics

・Practical education environment for understanding cultural diversity
・Language practice environment to improve communication skills
・Cultural ethos of Australia

Research Seeds

○ System for student support

Regarding multiple cultures and diversity, relations with other countries and foreign people might be roundly discussed. However, personal relations in daily life reflect an important diversity of culture and communication. Education related to communication and culture must start with education about mutual understanding and coexistence in daily life. We investigate students' supporting needs and will try to set up desirable environment in which they can receive appropriate counseling services and advice.

○ Operation and management of a CALL system to improve communication skills

The core factor to improve communication skills is language education. To raise such skills, it is important for us to build an interactive language practice environment. We will study the necessary operation and management system to raise the effectiveness of the Computer Assisted Language Learning (CALL) system. Then we can study ways to use it in the most effective manner.

○ Geography education for understanding the diversity of culture and daily lifestyles

To improve communication skills, it is desirable for everyone to understand the culture and daily lifestyles in other places, and to try to coexist with people with different cultures. It is difficult to prepare such an educational environment using language education resources alone. We expect to construct geography education to help learners understand topography as basic knowledge for improving communication skills.

○ Cultural ethos of Australia: an advanced multi-cultural society

Australia is a country in which many immigrants live together. Australians respect the diversity of their immigrant population and recognize its social and economic benefits. They are positively trying to build an environment in which people with different languages and lifestyles can improve their communication skills. We examine the cultural ethos of Australia as a model of a society in which multiple cultures and ethnic backgrounds coexist.

As described above, combining benefits of the respective field, we expect to examine ways to build an academic education environment in which students can learn the diversity of culture and communication in more multidimensional and organic ways.

Related Technology

・Practical system for diversity education
・Information about culture and daily lifestyles in Australia

Pedagogy

Pedagogy

(1) Dialects of Miyagi Prefecture
(2) Japanese Language and Culture Education for Both Japanese and Non-Japanese

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Keywords	Japanese linguistics, Dialectology, Sociolinguistics (02070), Japanese language and culture education (02090)

Research Topics
・Dialects of Miyagi Prefecture
・Methods of writing and speaking Japanese appropriately as a mother tongue
・Japanese language and culture education for non-Japanese

Research Seeds

・Because society is changing drastically, dialects, especially vocabulary, are in danger of extinction. Therefore, recording them is an urgent mission. Therefore, I survey and describe dialects of Miyagi Prefecture. Recently, with researchers in Japan and abroad, I am studying the difficulties posed by "language friction" in medical fields.

・Communicating with others well on both verbal and written aspects is necessary to become good engineers and good citizens. Therefore, I study the method of being interested in words and using them appropriately.

・Now I am in charge of Japanese and Japanese culture classes not only for Japanese students but also for overseas exchange students. Through classes, I study to give Japanese students an excellent opportunity to think about Japanese culture and give overseas exchange students an excellent opportunity to experience not only traditional Japanese culture but also daily Japanese culture.

Related Technology
・Information of dialects of Miyagi Prefecture
・Classes particularly addressing Japanese literacy and culture

Linguistics

Applied Linguistics

Toward Future Nanoscale Biomolecular Computing using Integrated Circuits

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Keywords	Life, health and medical informatics-related (62010), Computational science-related (60100)
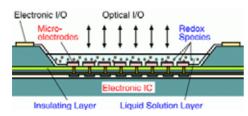
Research Topics

・Biomolecular computing and bioelectronics
・New computing paradigms

Research Seeds

We explore the possibility of constructing high-density parallel computing architectures using molecular electronics technology. New circuit and system integration modes can be realized using molecular computing devices. To clarify the proposed concept, an experimental model of a redox microarray is presented. A first experimental system for a redox microarray consists of a two-dimensional array of platinum microelectrodes to catalyze reversible reactions of redox-active molecules. Experimental results related to active wave propagation in the redox microarray are presented to demonstrate the potential of molecular computing devices for specific target applications.

Redox microarray: an experimental prototype of a molecular computing integrated circuit.

Electrochemical implementation of molecular computing integrated circuits.

・References
[1] M. Hiratsuka et al., International Journal of Nanotechnology and Molecular Computation, Vol. 1, No. 3, pp. 17–25, July 2009.
[2] M. Hiratsuka et al., International Journal of Unconventional Computing, Vol. 4, No. 2, pp. 113–123, 2008.
[3] M. Hiratsuka et al., IEE Proceedings – Nanobiotechnology, Vol. 150, No. 1, pp. 9–14, June 2003.

Related Technology

・Computer science
・Nanobiotechnology

Engineering

Computer Science

Developing Reliable and Safe Software

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Keywords	Mathematical informatics-related (60020), Software-related (60050)

Research Topics

・Mathematical logic
・Formal methods
・STAMP/STPA

Research Seeds

1) Mathematical Logic
Mathematical logic is a background of formal methods. We develop logics for formal methods. Recently, we are developing a frame of well-formed requirement documents based on argumentation theory, which is an extension of mathematical logic.
Papers:
1. A Bayesian Approach to Argument-Based Reasoning for Attack Estimation, Hiroyuki Kido and Keishi Okamoto, August, 2017, Proc. Twenty-Sixth International Joint Conference on Artificial Intelligence, IJCAI-17, pp.249–255
2. Balancing Between Cognitive and Semantic Acceptability of Arguments, Hiroyuki Kido and Keishi Okamoto, July, 2017, Knowledge Science, Engineering and Management: 10th International Conference, KSEM 2017, Melbourne, VIC, Australia, August 19-20, 2017, Proc. (Lecture Notes in Computer Science), pp.160-173

2) Formal Methods
Formal Methods are methods to develop software that is highly reliable, safe etc. We develop a translation tool from a specification language VDM++ to a programing language C#. We also give models that are first-order descriptions to verify refinement relations.

3) STAMP/STPA
STAMP is a novel accident model developed by Nancy G. Leveson. STPA is a hazard analysis method based on STAMP. We explore case studies to promote STAMP/STPA in Japan, and propose extensions of STAMP/STPA.
Papers:
3. はじめてのSTAMP/STPA(実践編), IPA/SEC, May, 2017, ISBN 978-4-905318-51-4, Information-technology Promotion Agency, Japan(IPA)
4. はじめての STAMP/STPA, IPA/SEC, April, 2016, Information-technology Promotion Agency, Japan(IPA)

Related Technology

Developing Flexible GUI Systems to Support Self-Learning

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Affiliated Societies	IEICE, JSIAM, JSEE
Keywords	utilization of ICT (09070), learning support (62030), discrete mathematics (12030)

Research Topics

・Developing a compact basketball data management system
・Developing a graph theory learning integrated support system
・Application of graph theory to network analysis problems

Research Seeds

・**Development of GUI System with high operability**

We are developing flexible GUI systems such as a basketball data management system (BM) and a graph theory learning integrated support system (GLIS) to support students' self-learning using C# programming language.

As presented in Fig. 1, BM consists not only of standard data input and analytical processing functions, but also of shot analysis functions that can analyze shot data in detail. Using BM, we can input data easily and efficiently with a pen or mouse, and can do various analyses while playing games. We also plan to implement additional functions in BM that can automatically advise teams or individual players in terms of technique, centrality, mental status, physical stress, etc. from the input data. Furthermore, by connecting two or more BMs to a mobile wireless router, BM users can share the input game data and analytical results in real time.

Fig .1 BM.

The GLIS presented in Fig. 2 is designed to support graph theory learning. Actually, GLIS has the following main functions: basic

Fig .2 GLIS.
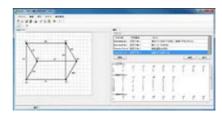
graph edit (graph drawing, delete or move vertices and edges), automatic conversion from graphs to various matrices, and plug-in in C programming language. Particularly, the plug-in function is important for self-learning of students. Using this function, users can produce analytical programs of the main body of GLIS independently; users can compile them, put them in a specified folder, and use them by selecting them directly from the GLIS menu. Now, we are improving the functionality and convenience of GLIS, and applying GLIS actively to graph and network analysis problems.

Related Technology

・Construction of flexible GUI systems in C# programming language

Constructing Regional Information Transmission Infrastructure using Area Broadcasting

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Affiliated Societies	IPSJ, IEICE, ITE
Keywords	Library and information science, humanistic and social informatics-related (90020)

Research Topics

・Identification and grasp of actual viewing area of area broadcasting
・Automatic generation of regional information contents

Research Seeds
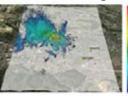
●Identification and grasp of the actual viewing area of area broadcasting

　Area broadcasting can be viewed on a home TV receiver. However, the receiving antenna of each household is directed to an existing broadcasting station. It is not necessarily pointed in the direction of the newly constructed area broadcasting station. Because the radio waves of the area broadcasting are weak, the influence of the signal level reduction caused by the difference in the receiving antenna direction is great. This research is aimed at establishing a method enabling identification and understanding of realistic viewable area, based on electric field strength distribution in radio wave propagation simulation and field strength measurement data.

●Automatic generation of regional information contents

　Area broadcasting TV is beneficial as a local information transmission medium because it can be viewed simply by pressing a channel button on the remote control with a home TV receiver. However, the production of broadcast contents takes much time and effort to gather broadcast materials and perform video editing work. Broadcast audiences want to obtain regional information in a timely manner. To realize that goal, it is necessary to devise a method of generating new broadcast contents. This research is based on the fundemental concept of placing information material on the PC screen and using the screen as broadcast contents. Multimedia processing is applied to various information materials acquired from the network. Furthermore, it sequentially maps them to frames of the previously designed broadcast screen image. As a result, it is possible to generate broadcast content that changes over time.

Estimation of viewing area with antenna direction.

Generating broadcast contents by Web scraping and mashup.

Related Technology

・Terrestrial digital broadcasting
・Radio wave propagation simulation
・Web scraping and mashup

Developing Application Software for Networks, etc.		
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Affiliated Societies	Information Processing Society of Japan; The Institute of Electronics, Information and Communication Engineers; Society of Computer Chemistry, Japan; The Chemical Society of Japan; American Chemical Society	
Keywords	Communication and network engineering-related (21020), Software-related (60050), Information network-related (60060), Information security-related (60070)	

Research Topics

- ・Delivery of WWW contents
- ・Difficulty of CAPTCHA using letters
- ・Wireless network maintenance and wave propagation improvement
- ・System applied for ID cards
- ・Recording and playback software for operations on PC
- ・Graphing for chemical structures

Research Seeds

・We are comparing display speeds between hyper-links and in-line images on a WWW page based on delivery conditions. Furthermore, we assess how to maintain and use WWW and its proxy server, and of PHP and SQL sites for study training.

IPSJ Tohoku Branch SIG Technical Report, 2016-7-B2-3 (March 2017)

・We are comparing differences between humans and computers (OCR) for difficulty of CAPTCHA using letters.

IPSJ Tohoku Branch SIG Technical Report, 2014-5-A1-2 (March 2015)

・We maintain of a wireless network and improve wave propagation, in a usual environment as a dormitory. This system is provided with 2.4 GHz and 5 GHz bands. This system is maintained and managed by RADIUS server in our laboratory.

Kosen Forum, PO_A32 (August 2013)

・We are developing systems applied for ID cards with IC chips and barcodes and magnetic stripes using our original reading program. Furthermore, a system has been applied for entering and leaving a room, and for a bicycle management system for a human (student ID cards with IC chips) and bicycle (key tag with IC chips).

Tohoku Kosen Sangaku-renkei Symposium T15-P-76 (December 2015)

・We are developing recording and playback software for operations on PC for consideration of supporting users and security. Now it can play back key-typing, mouse-control by buttons and wheel and tracks, and windows with position and size and foreground or background for a target application.

IPSJ Tohoku Branch SIG Technical Report, 2013-4-15 (December 2013)

・We graph chemical structures. Furthermore, we are developing several programs for estimation to connectivity from a rational formula, and generation of two-dimensional coordinates and drawings.

The Chemical Software Society of Japan, 304 (November 2000)

Related Technology

- ・Server construction and maintenance

Engineering

Computer Science

Information Delivery Infrastructure

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Affiliated Societies	IPSJ
Keywords	Network architecture (60060), Network management (60060), Service platform technology (60060)

Research Topics
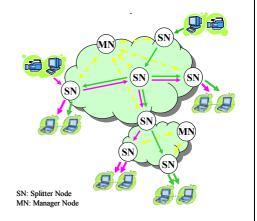
・Efficient content delivery methods for information networks
・Application of information and communication technology (ICT) for local communities

Research Seeds

The use of video streaming on IP networks, such as the internet, has been increasing through advances in computer and network technologies. The video stream uses wide bandwidth and occupies network resources for a long time; efficient delivery is necessary.

Our research group has been studying information delivery infrastructure technology in computer networks, one of which is a multipoint video delivery system.

An application level overlay network is formed using splitter nodes and manager nodes. The splitter node delivers video streams to clients or other splitter nodes. The manager node controls the delivery network. The structure improves video streaming efficiency and reliability and decreases operation and management loads.

SN: Splitter Node
MN: Manager Node

Multipoint video delivery system.

Additionally, we have been working on research and development for efficient content delivery such as on-demand delivery method according to user demands for contents, and a multicast delivery method based on Software-Defined Network (SDN).

Related Technology

・Operation and management technology of information network
・Application software development for information services

Engineering

Computer Science

Software Development Process to Deliver Value

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Keywords	Software engineering (60050), Embedded system (60040)

Research Topics

1. Model-driven development of software for autonomous robots
2. Development of web applications for education

Research Seeds

Practice of model driven development methodology for embedded system

The importance of model-driven development is strongly recognized for creating software with high quality and high reliability at the development site of embedded software. Model-driven development is a software development methodology that uses a software design model which represents concepts or topics related to a specific problem to be solved. To promote model-driven development, we are providing useful reference design models for embedded industry fields. We are also proposing various verification methods that use models effectively in software development process.

Practice of web application development with agile development method

To develop valuable software, methods based on hypothesis verification are very effective. In recent years, agile development has attracted attention as a hypothesis verification type development process. We have developed an educational application for children and a medical diagnosis support system using agile method. We have also been verifying the method's effectiveness.
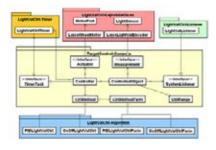
Fig. 1. Design model of autonomous robot control software.

Fig. 2. Usability test of educational application for children.

Related Technology

・UML/SysML Modeling
・Agile (Scrum)

Engineering

Computer Science

Intelligent Agent Technology: User-Oriented Service Provisioning System based on a Multiagent Framework

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Keywords	Agent (61030)

Research Topics
・Multimedia network middleware based on a multiagent framework
・Dynamic construction scheme of multimedia processing system
・Behavioral characteristics model for user-oriented multiagent systems

Research Seeds

●Multimedia communication system based on a multiagent framework

　In recent years, through the rapid development of the internet technologies, use of multimedia communication services on networks is increasing. Moreover, their uses are becoming personalized. Nevertheless, it is difficult for novice users of conventional multimedia network applications to receive stable services that are adaptable to changes in both user requirements and network/platform environments.

　In our laboratory, we propose a dynamic construction scheme of multimedia processing function from software components in multimedia network middleware. Especially, to overcome the difficulties described above, we propose flexible network middleware based on multiagent computing technology.

●Design and control models for multiagent systems

　In multiagent systems, overall system behaviors are extremely context-sensitive and non-deterministic because behaviors of the respective agents are decided dynamically using embedded knowledge of individual agents. Moreover, multiagent systems are distributed systems that compose the organization by the agent group that operates autonomously and behaves as an entire system through agent cooperation. Consequently, it is difficult to define the system functions and to eliminate undesirable actions in an initial design phase of the system. This great hurdle is construction of usable multiagent systems.

　We propose a method developed in our laboratory to observe and control behavioral characteristics of multiagent systems to support the design, development, and operation of multiagent systems. Especially, to overcome the difficulties described above, we propose a Flexible Distributed System and a Behavioral Characteristics Model for multiagent systems.

Related Technology
・Ubiquitous software services
・Multiagent self-organization
・Complex behavior characterization and engineering

Motion Control for Industrial Fields

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Keywords	Control and system engineering-related (21040), Robotics and intelligent system-related (20020)

Research Topics

・Haptic robot system for medical fields
・Force Sensor-less force control system
・Vibration suppression control system
・High-speed and high-accuracy position control system

Research Seeds

● **Medical robot system using bilateral control theory**

In recent years, realization of haptic systems is desired strongly in fields of medical treatment and expert skill acquisition. Minimally invasive surgery (MIS) has attracted attention for about ten years. MIS considers a patient's quality of life (QOL) greatly. Especially, development of endoscope surgery is superior to conventionally performed surgical operations. Its influence on society and economy is extremely strong. Furthermore, many researchers have strived to develop a medical robotic system.

However, the operator receives no feedback of tactile sensation. The operator obtains tactile sensation solely by visual feedback only. The present medical robot, which lacks this haptic function, has many attendant risks. Tactile sensation is important for surgery in various fields.

Many studies have specifically examined bilateral control to attain the vivid tactile feedback from the remote environment. In a conventional bilateral robot, much research has emphasized force sensors to detect force. Sensors using a strain gauge are well-known, but present many difficulties that affect performance of bilateral control.

To overcome these difficulties, this research proposes a sensor-less force control method using a reaction torque observer. As a result, the proposed bilateral system solves the force sensor's problems. This algorithm has wide application in industrial fields.
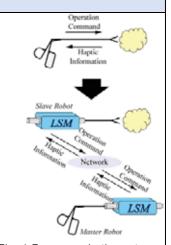
Fig. 1 Forceps robotic system.

Fig. 2 Bilateral robot system.

Related Technology

・High-speed and high-accuracy position control technology
・Force sensor-less technology
・Force control technology

Flexible Multifunctional Sensor based on Poly (Vinylidene Fluoride) Thin Film

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Keywords	Organic materials, Thin films (21050) Sensor materials (26040)

Research Topics

・Fabrication and design for the poly(vinylidene fluoride) (PVDF) film
・Application of PVDF film to hydrogen gas sensors and pressure sensors

Research Seeds

Fabrication and design of PVDF film

The conventional PVDF-based sensor fabrication process is complicated and time-consuming. We have developed a simple method of synthesizing β-phase PVDF film that is useful for flexible multifunctional sensors such as hydrogen gas sensors and pressure sensors[1]. The PVDF film synthesized using the wet process has a porous structure consisting of PVDF microscaled grains. This porous structure provided a better distortion property, which is suitable for our proposed sensors. Our sensors provide the important benefit of operation at room temperature without a power source[2].

Fig. 1 Response curves of Pd-coated PVDF hydrogen gas.

Application of PVDF film to hydrogen gas sensor and pressure sensor

Fig. 1 shows output voltage versus time curves of a sensor exposed to different concentrations of hydrogen gas. It is evident that the output voltage increased with increasing hydrogen concentration[3]. The output voltage, which is determined by the volume expansion of the Pd film deposited on PVDF film, accordingly depends on the hydrogen concentration.

Fig. 2 presents the output voltage curves collected using a tapping pressure sensor when tapping on the sensor with a finger. Our PVDF film can be applied to other types of sensors such as tactile sensor and sphygmomanometer because the PVDF film can be formed rather easily on flexible polymer films.

Fig. 2 Response curves of the PVDF pressure sensor for tapping stimulus.

(1) Pat. 6048870. (2) Y. Imai *et al.*, Appl. Phys. Lett. **101**, 181907 (2012).
(3) Y. Imai *et al.*, Sens. Actuators B, **247**, 479-489 (2017).

Related Technology

・Fabrication of organic piezoelectric film
・Measurement of sensor response characteristic

Engineering

Material Engineering

Assistive Technology for Supporting Education and Living for People with Disabilities

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Keywords	Learning support system-related (62030) Medical assistive technology-related (90150)

Research Topics

・Assistive technology for education of children with severe physical disabilities
・Support system for communication development of children with severe physical disabilities

Research Seeds

◇Assisteve devices to support education for children with severe physical disabilities

We are developing devices (mainly using microcontrollers) and software to support educational and learning activities at schools for special needs education for children with severe physical disabilities. Figure 1 shows devices supporting the switch activity developed to date. These are provided as kits.

◇Online communication-development-support system for children with severe physical disabilites

For children with severe physical disabilities who can not speak, early communication development support is necessary. We are developing a communication development support system aimed at supporting communication using a communication aide. Figure 2 shows the system overview. The system consists of training contents and a visualization system for learning outcomes. This collaborative research is conducted along with a speech-language-hearing therapist.

(a)   (b)

Fig. 1 Developed AT apparatus.
  (a)Switch Latch and Timer
  (b)Switch IR learning remort controller

Fig. 2 Communication development support system for children with severe physical disabilities.

Related Technology

Er:YAG Laser Delivery System for Medical Applications

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Affiliated Societies	IEICE, The Laser Society of Japan, IEEJ
Keywords	Electron device and electronic equipment-related (21060)

Research Topics

・Medical applications using hollow optical fiber
・High-performance laser device
・Very thin hollow optical fiber

Research Seeds

Infrared Laser Delivery System for Medical Applications

Er:YAG laser light with 2.94 μm wavelength is gaining popularity in dental applications. Hollow optical fiber for delivering infrared laser light has been successfully developed. In dental applications for treatment of root canal, there is a critical requirement for ultra-thin infrared fiber. It is possible to shorten the treatment time by using Er:YAG laser light.

Figure 1 shows the experimental setup for Method1 silver plating in the capillary tube. The plating solution and reducing solution were forced to flow through the glass capillary. In method 1, to increase the flow rare, we made 16 bundles for 75-μm bore glass capillaries.
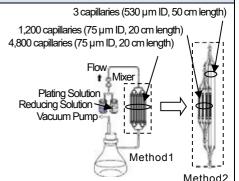
Fig 1. Experimental Setup for Depositing a Silver layer inside the glass capillary.

As presented in Fig. 1, each bundle was connected in parallel. However, because it uses 4,800 glass capillaries, it takes fabrication time and cost. Therefore, we propose method 2: four bundles of 300 pieces of silica capillaries with 75 μm inner diameter and 20 cm length were bundled. Furthermore, four bundles with 530 μm inner diameter and 50 cm length and three silica capillaries (dummy tube) with 75 μm inner diameter and 20 cm length were connected in parallel. The flow rates were, respectively, 60 and 50 ml/min for method 1 and method 2.

Losses for the 75-μm-bore size, 10-cm-length silver hollow optical fiber were 4 and 5 dB at 1 μm wavelength (excited by a Gaussian beam with FWHM=10.6°), respectively, for method 1 and method 2.

Using the dummy tube as a method of making a silver hollow optical fiber with 75 μm inner diameter, even with reduction to a quarter of the total number of the capillaries, results showed the possibility of fabricating useful ultra-thin silver hollow optical fiber.

Related Technology

・Fabrication of Hollow Optical Fiber
・Fabrication of High-performance Laser Tip
・Measurement of Transmission Characteristic of Hollow Optical Fiber

Developing a Language Training System

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Affiliated Societies	The Japan Society of Applied Physics
Keywords	Educational technology-related (09070)

Research Topics

・Development of language training applications
・Construction of language training systems

Research Seeds

●Language training applications

People having difficulty with language communication such as aphasia patients, children with learning disabilities, and dementia patients need language training according to their symptoms and capabilities. Technical support is necessary to reduce the labor needed for Speech-language-hearing therapist (ST) and others for preparing and managing language training.

We are developing language training applications for tablet devices that enable STs, etc. to add or change pictures for teaching materials for individual patients (Fig. 1).

●Language training system

To maintain and improve motivation for language training of patients, we construct a language training system with the semi-automatic question setting function reflecting the patient's answer tendency, and the control functions to change pictures of language training according to a patient's physical condition or symptoms (Fig. 2).
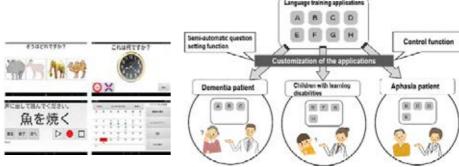
Fig. 1 Language training applications.   Fig. 2 Language training system.

Related Technology

・Teaching-learning support systems

Developing Novel Educational Equipment for Optics and Optical Technology

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Affiliated Societies	IEEE, SPIE, IEICE
Keywords	Optical engineering and photon science-related (30020) Electron device and electronic equipment-related (21060)

Research Topics

・Educational equipment for optical technology using block type optical devices
・Waveguide sensors for liquids using gapped optical fibers
・Application of nanoclusters for novel optical devices

Research Seeds

At our laboratory, we develop novel educational equipment for optics and optical technology. The educational equipment comprises cubic or rectangular block type optical devices as shown in Fig. 1. Block type optical devices are designed as a laser beam incident at the cube center. Because expensive manipulators and optical bases are unnecessary, the educational equipment is inexpensive; students can study optics and optical technology easily using it in experimental classes. We have developed various block type optical devices including a laser system, an optical detector, a sample holder, a color filter, a polarizer, a wavelength plate, a beam splitter, a grating, and a cell for liquid. We confirmed that various optical experiments can be done using educational equipment with block type optical devices. Results measured using our educational equipment are very accurate: similar to those obtained using commercially available optical devices.

We also investigate a waveguide sensor using a gapped optical fiber as shown on Fig. 2 for measuring the refractive index and absorption of liquid as educational equipment. The gap formed in the single mode optical fiber is filled by a liquid with optical characteristics that to be measured. Because optical loss of the gapped optical fiber depends on the refractive index and absorption of the liquid in the gap, the refractive index and absorption can be measured using two waveguide sensors with different gap widths. We experimentally confirmed the basic operation of this sensor.
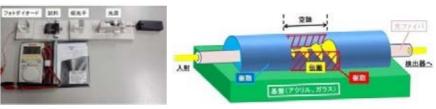
Fig. 1 Block type Optical Devices.   Fig. 2 Waveguide sensor using gapped fiber.

Related Technology

・Educational technology
・Non-destructive Inspection
・Remote sensing and control

Problem Solving of Local Industries and Communities using IoT

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Keywords	Embedded system (60040), Sensor network (60060), IoT (60060)

Research Topics
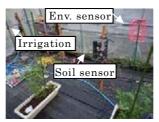
・ICT in agriculture
・Regional observation support system
・Mobile application to encourage local tourism
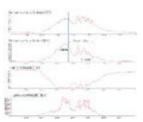
Research Seeds

Applications of IoT system

The following figure shows a system of sensing and control of multiple greenhouses in a region as an example of our studies.

Side curtains

Env. sensor

Irrigation

Soil sensor
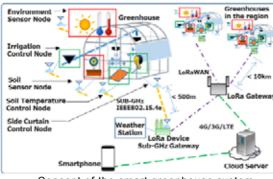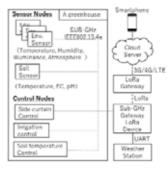
Outside (left) and inside (right) of the developed greenhouse　　Graphs of the sensors

Concept of the smart greenhouse system　　　　IoT system configuration

Related Technology

・Embedded system programming
・Mobile applications and web services
・Electronic circuit design

High-Sensitivity Magnetic Sensor Application for NDE and Ultra-Fine Magnetic Recording	
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Affiliated Societies	Japan Society of Applied Physics
Keywords	Measurement engineering-related (21030), Control and system engineering-related (21040), Electron device and electronic equipment-related (21060)
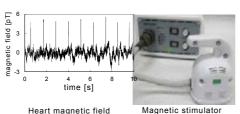
Research Topics

・Fine magnetic field detection using STM-SQUID Microscopy
・NMR/NQR measurement
・Ultra-fine magnetic recording with scanning tunneling microscopy

Research Seeds

Spintronics and electronics of nanostructures
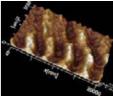
We developed a STM-SQUID probe microscope. A SQUID probe microscope was combined with a STM. Both topography and magnetic image of the sample surface were measured simultaneously. The microscope can be used for ultra-fine magnetic recording by generating local field from the probe tip.

STM-SQUID microscope

Magnetic image of HDD

Heart magnetic field

Magnetic stimulator

Nondestructive evaluation for safety

We developed NMR and Nuclear quadrupole resonance (NQR) measurement systems. We are developing nondestructive evaluation system to measure large samples and small samples.

Field detection/generation for human health

We measured the magnetic field from a human heart with pico tesla order using an RF-SQUID magnetic sensor. We are corroborating with IFG Cooperation, Sendai. The magnetic stimulator "PathLeader" was developed. This has been used in rehabilitation for patients with paralysis of limbs caused by stroke.

NMR spectrometer

FEM simulation

Related Technology

・Field detection/generation for research on spintronics and electronics
・Finite element method simulation
・Analog and digital signal processing and automatic measurement system

Preparating Electronic Devices using Zinc Oxide

Yasuhiro KASHIWABA

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Affiliated Societies	JSAP, IEEJ
Keywords	Electric and electronic materials-related (21050) Electron device and electronic equipment-related (21060)

Research Topics

・Epitaxial growth of ZnO films
・Structural analysis of ZnO and ZnO-related materials
・Fabrication of electron devices using ZnO and ZnO-related materials

Research Seeds

Zinc oxide (ZnO) has attracted attention as a material for new electronic devices. It has the following useful features: (1) large exciton binding energy of 60 meV, (2) wide band-gap energy of 3.37 eV, (3) low resistivity of n-type conductivity, (4) strong piezoelectric property, and (5) eco-friendly. The research purpose of our group is fabrication of various electronic devices with useful properties of ZnO.

Main research contents of our research group are listed below:
i) epitaxial growth of ZnO films; ii) structural analysis of epitaxial ZnO-related films and bulk crystals; iii) fabrication of a palladium (Pd)/ZnO Schottoky barrier diodes (SBDs); and iv) fabrication of ultraviolet (UV) sensors using ZnO films and bulk crystals.

For i) and ii) above, non-polar ZnO films (Fig. 1) are deposited on single-crystal Al_2O_3, $NdGaO_3$ (NGO), and ZnO substrates [1, 2]. The crystal structure of non-polar ZnO films or ZnO bulk crystals is characterized using X-ray diffraction (XRD). In this research, high-quality non-polar ZnO films with a flat surface, good structural and photoluminescence properties were achieved on several single-crystal substrates. In the research described in iii), Pd/ZnO SBDs are prepared and current-voltage (I-V) characteristics of SBDs are measured [3]. The I-V characteristics are improved remarkably by hydrogen peroxide (H_2O_2) treatment [4] for single-crystal ZnO substrates. In research of iv), UV sensors are fabricated using single-crystal ZnO bulks and polycrystalline; ZnO films are prepared using metal organic chemical vapor deposition (MOCVD). Characteristics of UV sensors are also improved by H_2O_2 treatment for ZnO films.

Fig. 1 ZnO film deposited on a single-crystal NGO substrate.

References

[1] Y. Kashiwaba et al., phys. stat. sol. A **206**, 5, 944 (2009).
[2] Y. Kashiwaba et al., J. Electron. Mater. **47**, 4345 (2018).
[3] Y. Kashiwaba et al., Appl. Surf. Sci. **286**, 126 (2015).
[4] Y. Kashiwaba et al., J. Appl. Phys. **113**, 113501 (2015).

Related Technology

・Structural analysis using the XRD system (bulk crystals and films)
・Preparation of metal films using vacuum evaporation apparatus
・Preparation of ZnO films using MOCVD

Optical Technologies for Image Acquisition, Processing and Display
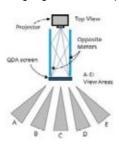
Senshi NASU	
Professor	nasu@sendai-nct.ac.jp
Affiliated Societies	Optical Society of Japan, Institute of Image Information and Television Engineers
Keywords	Optical information processing (30020), Measurement systems (21030)

Research Topics

・Highly functional displays
・Measurement system based on optical methods

Research Seeds

　　I am interested in two research fields: information display with high function such as multi-view or 3D; and an automatic measurement system based on applied optics. Interested in both research fields arose from my earlier study of optical computing for image recognition or image processing. It was based on liquid crystal devices and optical interference or optical Fourier Transform.

　　In recent years, I have engaged in collaborative research for developing multi-viewing displays (see Fig. 1 and Fig. 2). In this system, opposite mirrors were used to realize multiple perspectives with a single projector. In other projects related to an automatic measurement system based on applied optics, we have improved the methodology for rapidly counting viable bacteria. In this study, a new method for acquiring images of small bacterial colonies without focusing was proposed using longitudinal chromatic aberration of imaging lens (see Fig. 3), Subsequently, rapid and automatic enumeration of viable bacteria was realized by consecutive observation using digital microscopy.

Fig. 1 Simple structured multi-viewing display with a single projector.

Fig. 2 Five images seen from the viewing angles shown below.

Fig. 3 Deep focusing area by lens with longitudinal chomatic aberration.

Related Technology

・Automatic detection of target bacteria on a stool examination by image processing
・Detection of mycelium with digital holography
・3D volume display with multilayered fog-screens

Developing Novel Electromagnetic Devices with High-Accuracy and Low-Cost Numerical Simulation

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Keywords	High performance computing-related (60090), Measurement engineering-related (21030), Disaster prevention engineering-related (25030)

Research Topics

・High-speed, high-precision, and finite-difference time-domain (FDTD) method using graphics processing unit and error analysis
・Object identification form GPR images using deep neural networks

Research Seeds

・High-speed, high-precision, and finite-difference time-domain (FDTD) method using graphics processing unit and error analysis

  The finite-difference time-domain (FDTD) method and the constrained interpolation profile (CIP) method, which are used for electromagnetic (EM) simulation in the time domain, require vast computational resources. Moreover, numerical dispersion error arises from central-difference approximation. We have developed a parallel computation algorithm on multi-node GPU clusters and error compensation method with dispersion relation equation. Using our method yields results that show good agreement with exact solutions.

・Object identification from GPR images using deep neural networks

  We have developed a method of identifying underground objects using ground penetrating radar (GPR) images analyzed with a deep neural network (DNN). In this study, to detect an underground object automatically from a GPR image by the DNN, we generated several hundred thousand GPR images for training the DNN using a fast finite-difference time-domain (FDTD) simulation with graphics processing units (GPUs). Furthermore, characteristics of underground objects are extracted and learned from generated GPR images by a nine-layer convolutional neural network (CNN). Results show that the CNN can identify six materials with roughly 80% accuracy in inhomogeneous underground media.

Related Technology

・Analysis of EM fields for EM devices (indoor/outdoor wireless communication, UWB, lightning, GPR, etc.)
・Parallelized for numerical EM simulations (FDTD, CIP, MoM, etc.)
・Construction of a cluster/grid environment on Linux
・Parallel programming techniques on clusters, grids, and GPUs

Engineering

Electrical/Electronic Engineering

Control System with Uncertain Conditions, Inverted Pendulum Control and Liq.-Level Control

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Keywords	Automation (20010), Control theory, Control systems (21040), Electric machinery, Power electronics (21010)

Research Topics

・Manufacturing development of two-axis liquid level control system with a liquid level sensor
・Research on swing up control of an inverted pendulum and advanced teaching materials
・Research supports for an economy with electric vehicles

Research Seeds

1. Inverted pendulum with inertia rotor (Fig. 1)

　Stabilization of an inverted pendulum with the rotor is basic control as a posture control robot ASHIMO. However, an inverted pendulum with a rotor stands the pendulum using the reaction force generated by giving torque to the force point. Our purpose is mainly realizing the swing control.

2. Nonlinear liquid level control system with two-axis (Fig. 2)

　We were performing studies or realizations of control models of various kinds using the concepts of PID optimal control and 2DOF PID control. These controllers are based on the robust control technology and are designed under the uncertain conditions with unexpected perturbation. It is the control purpose to suppress the oscillations of compound waves on a liquid surface.

3. Sequence control

　We develop an inverted pendulum system as teaching materials for intermediate engineers by application of the sequence control technique. Some merit exists by which PLC has visual software because PLC can be treated with a CPU of the so-called sequence.

Fig. 1 Swing type inverted pendulum.
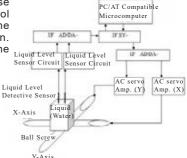
Fig. 2 Liquid level control system with X-Y.

4. Research supports for eco-running electric vehicle (Fig. 3)

　We have been developing a regenerative system to collect heat energy when braking in ultra-compact electric vehicles in a colleague's laboratory. Furthermore, Support has been given for evaluation and research mounted on an electric vehicle for an economy running competition. We participated in a competition at Sports Land SUGO in Miyagi.
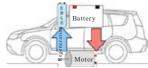
Fig. 3 Regenerative system in Eco-Run.

Related Technology

・Design and development of 2DOF liquid level control system
・Building and design of robust control systems with uncertain conditions
・Software development of the inertia rotor type control system design
・Various kinds of research support related to electric vehicle manufacturing

Engineering

Electrical/Electronic Engineering

Environment Recognition using Wireless Personal Area Networks

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Affiliated Societies	IEEE, IEICE and IEEJ
Keywords	Electrical and electronic engineering (21020), Information science, computer engineering and related fields (60060, 60050, 60100)

Research Topics

・Interference reduction in a many IEEE802.15.4 terminal environment
・Communication quality assurance among standards of wireless communication
・Localization and estimation of traffic congestion using wireless personal area networks

Research Seeds

Environment recognition using Wireless Personal Area Network

The ubiquitous age has arrived. Low battery sensor devices have become important. The IEEE802.15.4 standard, which is made for sensor networks, allows numerous terminals to be connected on a single network. However, interference from many terminals has increased. We propose a method of interference reduction for IEEE802.15.4. Our proposed method uses grouping and waiting. The experiment was conducted in an actual environment using 8 and 16 terminals. Figure 1 presents our experiment results: our method is faster than the current one.

Experiment for interference

Moreover, we apply this method to estimation of traffic congestion. Constructing a server-less network is a unique characteristic among systems. Figure 2 presents our proposed model. We propose a system to estimate the traffic congestion distance using IEEE 802.15.4, which is extended by multi-communication frequency division multiplexing. Our proposed system is developed at a 20% equipped rate, in which five lanes are considered. Furthermore, for our proposed

Localization system for safety

system, it is assumed that the equipped rate in all lanes increases. Our proposed method can estimate an error rate of lower than approximately 10% at an equipped rate of greater than 50%. Additionally, we use 16 terminals in the actual environment.

Related Technology
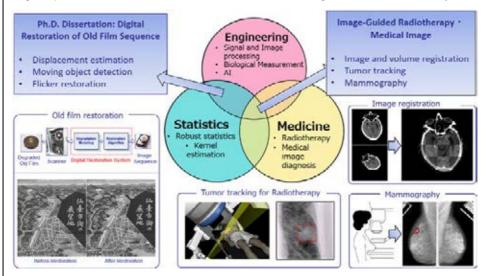
・Technology of interference reduction for IEEE802.15.4
・System development with wireless personal area networks
・Estimation of traffic congestion using wireless personal area networks

Engineering

Electrical/Electronic Engineering

High-Accuracy and High-Speed Digital Image Processing and Recognition

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Keywords	Biomedical engineering (90110) Tumor diagnostics and therapeutics (50020) Life, health and medical informatics (62010)

Research Topics

- Digital restoration of old film
- High-accuracy image registration
- Image-guided radiation therapy
- Computer-aided diagnosis

Research Seeds

Digital image processing is an important field in information science. It has been applied widely to various applications. Our study specifically examines development of high-accuracy and high-speed image processing and recognition algorithms for several applications such as image restoration and medical image applications. The following diagram presents our recent studies and the related technologies involved in our study.

A publication list can be found in the following URL:
https://researchmap.jp/7000000486/?lang=japanese

Related Technology

- Oncology
- Radiation therapy
- Medical imaging

Data Analysis and Machine Learning

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Affiliated Societies	Physical Society of Japan Information Processing Society of Japan
Keywords	Multilayered Neural Network, Numerical modeling, Sensor data analysis (61040)

Research Topics

- Application of multiple neural network systems
- Analyzing various sensor data
- Studying traffic jam and flow mechanisms using numerical simulation
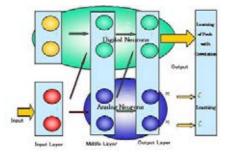
Research Seeds

Internet technology enables us to collect information of various types more easily. Sensor technologies make us monitor various time sequential activities such as human activity and environmental conditions. Such data collected through the internet and/or various sensors are designated as "Big data". The analysis of "Big data" and its applications are recent hot research topics. Deep learning, artificial intelligence, and/or machine learning are new technologies that provide us means of extracting certain meanings from such large amounts of data. A neural network is fundamentally important for those technologies.

Realization of a flexible information processing system based on neural networks might provide us a new type of efficient data analysis.

Through continuous research work on stochastic digital neural networks and analog neural networks obtained by application of the mean field approximation to digital one, we have derived a learning rule that shows excellent scalability and a stable learning tendency. This scalability guarantees a stable learning tendency without regard to network size and provides us many degrees of freedom for constructing network structures. These results demonstrate that we can obtain a system with higher ability by optimizing the structure of multiple neural networks.

We explore the possibility of constructing a new flexible support system for human information processing activities by multiplying these neural network systems including digital and analog neurons. Digital and analog neuron systems are presumed to share processing jobs depending on the feature of cases. We might be able to construct more generalized processing systems by combining these with respect to a type of problem. This multiple neural network structure can be applicable to various systems such as flexible data processing systems for various ambiguous data, self-organizing computer networks, and data transfer controlling systems on multimedia communication networks.

Related Technology

Developing New Information Systems Based on Neural Networks

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Affiliated Societies	IEICE, The Japanese Society for Evolutionary Computation
Keywords	Neural network, Evolutionary computation, complex systems (61040)

Research Topics

・Modular neural networks
・New concept neuron model
・Neural system design for combinatorial optimization problems

Research Seeds

Most existing neural network models interpret biological behaviors in terms of time-averaging techniques rather than direct emulation. It is a reasonable simplification to handle macroscopically the collective computational properties of the networks. However, the direct emulations are main concerns to the single or microscopic neuron models. Therefore, we have proposed the Inverse function Delayed Model (ID model) to represent networks with neurons in a critical state. The most important feature of the ID model is to include negative resistance dynamics.

Neural networks have been used for solving combinatorial optimization problems that require finding the best combination for a minimum or maximum cost. Then they compute in parallel and do so rapidly. However, the existence of local minima has posed a severe difficulty: it interferes with searching global minima as the optimal solution. Our proposed ID model can destabilize undesirable stable states actively using negative resistance, so that we expect that the ID model is a powerful tool to find an optimal solution of a combinatorial optimization problem.

At our laboratory, we are developing various new information systems using neural networks such that a system can solve combinatorial optimization problems.
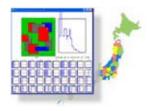
Fig. 1: Four color problem.

Fig. 2: Minesweeper.

Related Technology

・Nonlinear dynamics
・Application development by neural network technology
・Parallel computation technology

Others

Informatics

Automatic Extraction of a Selected Area from an Image

Toshiaki OKUMURA
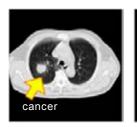
Professor	okumura@sendai-nct.ac.jp
Affiliated Societies	The Institute of Electronics, Information and Communication Engineers
Keywords	Image processing (61010), Pattern recognition (61010), Computer vision (61010)

Research Topics
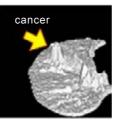
・Selection and extraction of a lung field area from a lung X-ray CT image used for physical checkups
・Detection of very small areas on an image
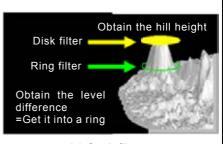
Research Seeds

・Detection of a very small area on an image

　We also are investigating a method of locating a diseased area of interest automatically on images obtained from a diagnostic supporting system that is used for the lung cancer examinations made based on chest X-ray CT images. The method we use currently uses a Quoit filter. The method drops two filters (a disk and a ring) from the top of the hill shown on the three-dimensional image (bird's-eye view representation) on which the density values are aligned toward its height direction on the two-dimensional image, as presented in Fig. 1(b). Then the dropped disk would stop at the top of the hill, but the ring would fall down to the foot of the hill (Fig. 1(c)). With the height difference thus shown by the two filters and using it as an output value, we can automatically detect an area (a very small area) that is smaller than the filter size and isolated on the image picture having a high density value there at that position.

(a) Original image　　(b) Bird's-eye view representation　　(c) Quoit filter

Fig. 1　Automatic detection of a lung cancer focus area

Related Technology

・Imaging analysis and automatic area selection and extraction on the image
・Detection of tiny isolated area of an image

Others

Informatics

Social Interaction among Humans, Information and Artifacts

Toshihiko ANDO

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Affiliated Societies	IEICE, IPSJ, ACM, The Society for Science of Form, Japan Center of International Theater Institute
Keywords	Human interface and interaction-related (61020)

Research Topics

・Communication design of human artifacts
・Dementia care support using "weak robots"
・"Natural" information sharing using NUI and AR

Research Seeds

Communication design of human artifacts

Artifacts such as robots have recently been introduced to human society. We have explored social requirements for such artifacts to be accepted for use in human society using motion analysis, field work, and a theatrical approach. We especially have developed a speech emotion recognition method and an emotional movement generation method based on communication model with emotion. Subsequently, we applied them to support the care for dementia or elderly people using robots based on the concept of "weak robots."

Natural information sharing using NUI and AR

We have developed natural information sharing applications by which people can share information and can work together through operation of virtual objects displayed on a smartphone or indoors or outdoors using natural user interface (NUI) and augmented reality (AR) technology. As a part of this, we realized a picture division method on two or more smart phones. Additionally, we have been developing a historical site information providing systems for learning local area history in a primary school or local community using AR.

Related Technology

・Motion analysis
・Application using NUI and AR
・Emotional voice analysis
・Instruction of acting and voice training

Developing an Electric Wheelchair with a Single-Step Climbing Mechanism

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Affiliated Societies	JSME, JSDE, JSEE
Keywords	Mechatronics(20010), Embedded system (60040), Assistive technology(59010), Social welfare for aging (08020)

Research Topics

・Achievement of single-step climbing function using six-wheel structure
・Establishment of communication between circuits using USB
・Development of motor control algorithm for four-wheel drive running

Research Seeds
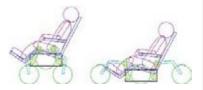
・Development of element technology necessary for achieving electric wheelchairs

When using wheelchairs and similar devices, barriers such as stairs can hinder movement. Although barrier-free structures have become widespread recently, field surveys [1] done in 2001 circumstances clarify that many small differences of single steps between the pavement and the roadway remain. Because slopes are associated with most multi-step differences, if small differences of only a single step could be surmounted, the electric wheelchair users' range of action could be extended enormously.

Consequently, electric wheelchairs with single-step climbing function are developed in this laboratory (Figs. 1 and 2). The prototype being developed now achieves single-step climbing function by adopting a six-wheel structure. Moreover, coexistence of the indoor use and the commuter use is attempted by transformation of the device between usual posture of four-wheel contact and the running posture of six-wheel contact.

This prototype has been developed with the intention of trial drive realization. It is a feature of the control system to use many subsystems and to use internal communication using USB.

Usual   Running/Climbing
Fig. 1 Structure of prototype.

Fig. 2 3D model of prototype.

[1] Tamura, Kondo, Kumagai, Oizumi: Development of a single step climbing mechanism for electric wheelchair (1st Rep.), SPTE, (2002)

Related Technology

・Brushless DC motor control technology
・Power electronics technology
・Built-in microcomputer technology

Others

Welfare Engineering

Spread of Rugby Football, Rugby Football Coaching

Yusuke KANEMURA

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Affiliated Societies	Japan Society of Physical Education, Health and Sport Sciences, Japan Society of Rugby
Keywords	Sports sciences-related (59020)

Research Topics
・Spread of tag rugby in Japan
・Game analysis of rugby football and tag rugby
・Coaching methods of rugby football

Research Seeds

・Research and development of rugby football coaching methods
We try to research and develop rugby football coaching methods for young players. We are coaching some teams, elementary school children, junior high school, college students, and women's teams. We use this experience to develop rugby football coaching methods.

・Spread of rugby football and tag rugby in Japan
In 2019, Japan hosts Rugby World Cup. Japan Rugby Football Union needs to spread rugby football among Japanese people. We support the spread of rugby football and tag rugby through teaching rugby to people of various ages. We teach tag rugby to elementary school children and investigate how to popularize rugby football and tag rugby in Miyagi prefecture.

・Game analysis about U-12 tag rugby

Related Technology
・Rugby football coaching
・Game analysis of rugby football

Natori Campus

Pure Abstract Algebras over Base Rings

Hisatoshi IKAI	
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Affiliated Societies	
Keywords	Group schemes; Quadratic forms; Exterior algebras, spinors; Jordan structures (11010)

Research Topics

・Group schemes associated with quadratic forms over base rings
・Exponential maps and Pfaffian in exterior algebras

Research Seeds

My major interest is in algebra: a branch of mathematics concerned with ``qualitative'' aspects, rather than ``quantitative'' aspects measured by real numbers. In more sophisticated nomenclature, the ``qualitative'' are replaced by ``structural'' and probably the ``structures of compositions'' are the subjects of study in algebra.

In mathematics, there are four known fundamental compositions: addition, subtraction, multiplication, and division. My research is worked out ``over base rings,'' in which one should refrain from operating division freely. Roughly speaking, I am an algebraist who cannot operate division.

Furthermore, I consider mathematics to be studied for its own sake and keep a style which can be regarded as ``abstract.'' Abstract mathematics glittered and glowed in the early twentieth century, but it looks rather out of date now. It seems appropriate not to consider me a scientist, much less an active researcher having good research seeds. I advocate against ``concrete'' mathematics, which some people value as the foundation of science and technology.

Related Technology

Morphologies of *Bacillus subtilis* Communities responding to Environmental Variation

Madoka NAKAYAMA

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Affiliated Societies	Mathematical Society of Japan	
Keywords	Mathematical modelling (12040), Physics of biological matters (13040)	

Research Topics
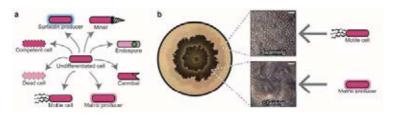
・Morphologies of *Bacillus subtilis* communities
・Mathematical model of colony formation
・Numerical simulation

Research Seeds

Spatiotemporal structures grown by bacterial communities exhibit diverse morphologies and functions. Studies of self-organization mechanisms and microbial population control strategies have reported on gene networks supporting cell differentiation. Conversely, isolated features of community morphology have been examined to assess the roles of individual genes in community development. However, morphological responses of bacterial communities to environmental variations are too diverse to be understood only at the molecular and cellular levels. The regulation of cell states affects macroscopic community morphology and the surrounding environment; the resulting environmental changes alter gene expression, dynamically defining cell properties.

Our recent work[1] reviews morphologies of *Bacillus subtilis* communities responding to environmental variations. We summarize how *B. subtilis* uses different cell types to adjust its macroscopic collective structure to a changing environment; we also discuss self-organization mechanisms and their underlying growth strategies. Finally, we introduce how observation of collective morphologies has been used in molecular biology assays, demonstrating the importance of interdisciplinary, multi-level investigations.

(1) Tasaki, S., Nakayama, M., Shoji, W. 2017. "Morphologies of *Bacillus subtilis* communities responding to environmental variation." *Develop. Growth Differ.* **59**, 369-378.

Related Technology

・Cell biology
・Environmental technology
・Food processing technology

Deciphering Undecoded Books in Japanese Mathematics and its Analysis

Miho TANIGAKI

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Affiliated Societies	Mathematical Society of Japan
Keywords	History of science (01080)

Research Topics

・Japanese mathematics
・Deciphering old books
・Math education

Research Seeds

Tohoku was once a lively land of mathematical research. Therefore, extremely valuable materials related to mathematics have been left in various places in Tohoku. In particular, Tohoku University Library has more than 12,000 mathematical materials. It is said to be the largest such repository in the country. Although cataloging by titles has been done, however, verification of their contents has been done only slightly: there are many undisplayed books. In addition, no concept existed of copyright in the publishing culture of the Edo period. Many similar books that imitated pirated copies and titles were issued for the propagation of books with excellent contents. Therefore, even if the title is the same, some books have different contents. Conversely, books with different titles exist even if the contents are the same. The actual quantity and contents of undecoded books on mathematics in Japan remain unknown.

When studying old Japanese mathematics, it is difficult for mathematicians to interpret the old books. For historians, mathematics is difficult. For this reason, the number of experts is in the country remains limited. Despite acknowledging their academic value, the current situation is that the decryption of new documents has not progressed much. Nevertheless, our school has teachers with expert knowledge related to the necessary subjects; moreover, Tohoku University Library is in the vicinity. This research is conducted in association with Associate Professor Akiko Tokutake and Associate Professor Madoka Nakayama of our school. Tokutake, who was working on interpreting old books of mathematics from the school days, is in charge of deciphering the old book. Nakayama and Tanigaki are in charge of deciphering and analyzing mathematics and verifying their academic and mathematical values.

Related Technology

・Elementary arithmetic
・Survey technology
・Science history of Miyagi prefecture

Physical Properties of Organic and Inorganic Functional Materials and their Applications

Koichi KUMAGAI

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Affiliated Societies	JSAP, JPS, JLCS, AIJ
Keywords	Mesoscopic systems, Surfaces and interfaces, Optical properties of condensed matter (13020), Liquids and glasses, Soft matters (13040)

Research Topics

・Preparation of organic molecular thin film; treatment and evaluation of orientation
・Preparation and characterization of transparent conductive film
・Polarized ultraviolet, visible, infrared absorption spectroscopy and Raman spectroscopy

Research Seeds

In flat panel displays (FPDs) and the like, thin films using various functional materials are applied. Such films include liquid crystal molecule thin films, transparent conductive films, alignment films, and polarizing films. Those have been mentioned, and various research results have been reported respectively. Nevertheless, despite many reports on the physical properties of individual functional materials, few cases exist of individual functional materials evaluated by measuring dynamic characteristics by model FPD (Fig. 1 and 2). In this laboratory, we developed functions by expressing functions and controlling functions by controlling morphology of organic and inorganic functional materials, developing functional materials applicable to FPD and the like, creating motion models, and evaluating the operating characteristics of model FPD. We are working to verify the performance of organic and inorganic functional materials.

Fig. 1 Measurement arrangement.   Fig. 2 Measurement result example.

In this laboratory, spin coating is carried out using a self-made spin coater in a small scale clean room located in the department to which it belongs; a low-temperature sintering process is carried out with a dry oven disposed in the same room. To fabricate of the transparent conductive film, an RF magnetron sputtering apparatus is arranged in the department where it is used. To evaluate the characteristics of the thin film produced, various spectroscopic analyzers such as polarized FT-IR (transmission, ATR, diffuse reflection), UV-Vis (double beam, transmission, reflection) and portable Raman, XGT, digital multimeter, and LCR meter. For evaluation of the dynamic characteristics of the model FPD, we used a self-made measuring system with a combination of a laser light source, various polarizers, a function generator and a DC power source, a high-speed / high sensitivity photometric element, 1 GHz band digital oscilloscope, etc. We also use polarizing microscope located in the laboratory to observe the anisotropy of liquid crystal molecules and so on.

Related Technology

Developing New Superconductors

Hotaka YAGYU

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Affiliated Societies	The Japan Society of Applied Physics
Keywords	Applied physical properties-related (29010)

Research Topics
・Developing new superconductors using hydrogen
・Improvement of cuprate superconductors

Research Seeds

Superconductivity encompasses phenomena such as zero electrical resistance, expulsion of magnetic flux fields, and the Josephson effect below a characteristic critical temperature. Superconductors are anticipated for wider application for MRI, and maglev trains, etc. Nevertheless, superconductors present some important issues. One is that the critical temperature is a very low temperature.

We study the improvement of a critical temperature by the synthesis of new superconductors as follows.

1. Using light elements such as hydrogen.
2. Partial substitution of cuprate superconductors.

First, hydrides have attracted much interest as possible superconductors with high critical temperature because of their phonons with high frequencies because of the small mass of hydrogen.

Second, a critical temperature of cuprate is relevant to the distance of Cu-O(apex). We attempt to extend it by partial substitution.

Related Technology
・Soft-chemical techniques

Developing Green Chemistry using a Three-Dimensional Ball Mill

Tomoaki ENDO

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Affiliated Societies	Chemical Society of JAPAN, AAAS, Electrochemical Society of Japan, American Chemical Society
Keywords	Environmental materials and recycle technology-related (64030), Organic functional materials-related (35030), Structural organic chemistry and physical organic chemistry-related(33010)

Research Topics

・Synthesis of new types of organic functional materials
・Mechanochemistry using a three-dimensional ball mill
・Development of a computer chemistry system

Research Seeds

The ultimate purpose of our research is contribution to the sustainable development of the Earth to produce useful new functional materials.

Recently, an excellent new style ball mill (Fig. 1: "Three-dimensional ball mill (3D-BM)") has been developed by a small firm, It is known as a Nagao System[1] in Japan. The 3D-BM has two rotation axes, which means that it allows those balls to move in three-dimensional space in the ball mill's cell, with such milling, it can eliminate friction heat over a long milling time. For that reason, it reduced heat damage to the sample during milling processes.

We are now applying 3D-BM to various organic chemical reactions. Additionally, we are developing the simulation program for 3D-BM using the "Distinct Element Method" to elucidate the 3D-BM's characteristics.

Starting Materials and Catalysts → **3d-BM** → etc
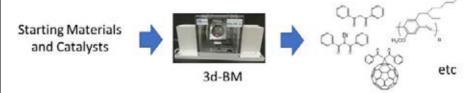
Fig. 1. Utilization of Three-dimensional Ball Mill.

This machine is effective not only for pulverization but also for agitation of highly viscous substances. We would like to develop a new excellent mechanochemistry as a tool for "Green Chemistry".

1) http://www4.plala.or.jp/nagaosystem/ (2018.08.01)

Related Technology

・Synthesis of fullerene derivatives, OPV materials, OLED materials, etc.
・Spectroscopy of NMR, UV-Vis, FT-IR, LC-MS, fluorescence and CV, etc.
・Molecular design: structure-property relation, molecular orbital calculation, molecular dynamics simulation

Community Design and Financial Education through a Community Currency

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Keywords	Economic policy-related（07040） Sociology-related（08010） Economic doctrines and economic thought-related（07020）

Research Topics

・Endogenous process of community design through community currency
・Developing financial education for community by using gamification
・Development history of modern economics in Japan through Miyoji Hayakawa

Research Seeds

My research interests include history of economic thought on community currencies (CCs) and endogenous development research in rural areas. Our study examines how community currencies affect community involvement and local economic development. In addition, I'm investigating Digital CCs harmonized with new payment platforms using communication tools in the world now.

The following are the main papers that have been published.

・Kurita, K., Yoshida, M. and Miyazaki, Y. 'What kinds of volunteer become more motivated by community currency? Influence of perceptions of reward on motivation' *International Journal of Community Currency Research* 19 (Summer), 2015, pp.53-61.

・Miyazaki, Y. and Kurita, K. 'The diversity and evolutionary process of modern community currencies in Japan' *International Journal of Community Currency Research* volume 22 (Winter), 2018, pp.120-131.

・Community currency and sustainable development in hilly and mountainous areas: A case study of forest volunteer activities in Japan"（Co-author）, In G. Gomez (Ed.) *Monetary Plurality in Local, Regional and Global Economies*, Routledge, 2018.

Related Technology

Constructing Digital Archives for Flipped Learning

Jun TAKEDA

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Affiliated Societies	Council of College Eng. Teachers (COCET), JPN Association of College Eng. Teachers (JACET), JPN Society of Eng. Language Education (JASELE), JPN Association for Educational Technology (JAET)
Keywords	Computer-assisted language learning, Teaching material, Language testing (02100)

Research Topics
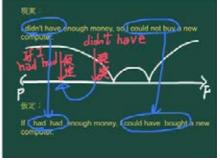
- ・Introducing flipped learning into English education at KOSEN
- ・How to develop digital movie materials for flipped learning
- ・Construction and sharing of digital archives for flipped learning

Research Seeds

・Introduction of flipped learning into English education at KOSEN.

The latest version of curriculum has made us choose Flipped Learning (FL) as an ideal method of English learning/teaching at KOSEN, has been executed on the entire class period of English. Takeda has put 166 video files on Blackboard Learn+, the official LMS for KOSEN, as well as on YouTube since 2014. Each file gives the fundamental grammatical explanation in approx. 5 min, with the result that the average viewing rate of each is 6.6 times per student. This method of FL has helped teachers reduce the time of "calibration" at the initial stage of each class. FL is now being adopted into other subjects taught at Sendai KOSEN, including math, chemistry, mechanical engineering and social studies.

・Development of teaching materials emphasizing KOSEN students.

There used to be few suitable teaching materials for KOSEN students, some were for the faculties of engineering; others were intended for industrial high schools. Takeda is an authors of five textbooks specifically designed for KOSEN students, which assign much more weight to expressions of fundamental scientific matters rather than on literary ones. Takeda is now constructing digital archives of learning/teaching materials of those textbooks on the web with some colleagues so that the FL would be conducted more effectively and smoothly with less reliance on the labor of KOSEN teachers.

Related Technology

- ・How to produce instructive movies with the applications for flipped learning, e.g., *Explain Everything* and *Keynote*.
- ・Instruction and reconfirmation of fundamental science in English.

American Literature and Culture

Kiyoshi IIDA

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Keywords	European literature-related (02040)

Research Topics

・Economical Evaluation of American Professional Sports
・Cultural Evaluation on American Popular Music

Research Seeds

   I have been studying Conservatism and Counter Swing in the Mind of the American Youth in the 1950s. My research method depends on Cultural Studies. I name it the theory of "cultural crossing," which also explains ambivalent feelings among different social groups. A culture born in a community is imitated by a social group in a neighboring community.   Then some idioms are added to the original to emphasize the receivers' collective identity.   The revisions are repeated while attenuating the differences until the subculture is received as an overculture.   Because the popularization usually includes confrontation within the society, the temporary unity soon diverges to consolidate the bonds of the respective groups.

Related Technology

Japanese Ancient History

Akiko TOKUTAKE

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Affiliated Societies	Tohoku Historical Society
Keywords	History of ancient Japan (03020)

Research Topics

・Study using The Shosoin documents
・Temple construction in ancient Japan(7th-8th century)

Research Seeds

　　I am studying how large structures at temples were constructed in ancient Japan. The following special point are assigned attention, (1)Organization, (2)Funds, (3)Securement of labor, (4)Securement of materials, and (5)Engineer's arrangements.

Published Papers

(1)The study of KonKomyoji-Zohbutsusyo.
　　Kokushi-danwakai-zasshi (56), 2015
(2)The consideration about the document called Edokoro-Ge. Kokushi-danwakai-zasshi (54), 106-121, 2014
(3)Pictures work and Painters in the Nara period of Japan.
　　Cultura antica 65(1), 43-61, 2013-06
(4)Reexamination of the organization for Amida-Jodo-in's construction
　　Historia (207), 31-53, 2007-11

Historical Science

Historical Science

Related Technology

・Decipherment of ancient documents

Repeating System of the Sacred and the Profane in Literary Texts

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Affiliated Societies	Jananische Gesellschaft für Germanistik
Keywords	German literature (02040) Narratology (02050)

Research Topics

・German literature of the 19th and 20th centuries
・Social relations appearing in literature
・Wiederholung von dem Heiligen und dem Profanen

Research Seeds

The study of literature has nothing to do with any economical profit or any kind of invention. Therefore, we cannot see or talk about this field from the viewpoint of seeds. Nevertheless, I think that it helps to provide introspection into our patterns of thinking and the social codes that we usually take for granted unconsciously.

For instance, it has been said in recent times that unlike the Occident, there is no "society" in Japan but "Seken," by which we obey pressure toward conformity rather than statutory law. Nevertheless, descriptions exist of acts in German literary texts of 19th century which we can read not as obedience directly to god. Characters commit a crime to conceal their sins from others. I call these groups of characters a sort of "Seken."

Related Technology

Literature

Litarature

Design Evaluation Based on Human Psychological and Behavioral Characteristics

Hanae ISHI

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Affiliated Societies	The Japanese Society for Cognitive Psychology, Japan Society of Kansei Engineering, Japanese Academy of Facial Studies, Tohoku Psychological Association
Keywords	Kansei psychology (61060), Perception (10040), Emotion (10040), Evaluation of design (90010), Human engineering (61020), Spatial design (90010), Information design (90010)

Research Topics

・Experimental psychological study of human psychological and behavioral characteristics
・Psychological evaluation of information design
・Psychological evaluation of architectural and space design

Research Seeds

My research interest is to clarify human psychological and behavioral characteristics using psychology and ergonomic methods and to consider such human characteristics scientifically to conduct design evaluations and to study effective design.

[Information design and gaze] Information such as newsflashes is sometimes aired on television through an L-shaped screen layout. This layout reduces the size of the main display area and provides information in the margins of the screen. This study examined the viewer's subjective evaluation and eye gaze when regarding this screen layout to assess appropriate screen designs for information display from the viewpoint of the television viewer [1,2].

a) information-displayed screen   b) normal screen
Fig. 1: Typical example of eye fixations. Viewing videos on information-displayed screens (a) rather than on normal screens (b) decreased the frequency of longer fixation durations [2].

[Spatial design and Kansei engineering] This study specifically addressed how a view from a room's window affects evaluations of the room's interior atmosphere [3]. The CG of the indoor space with different views from the window was evaluated using the semantic differential method to discuss the importance of window planning in the creation of a room's atmosphere.

a) scenery of nature   b) scenery of residential area
Fig. 2: Spaces with different views of the window. Difference in the window's view changed the evaluations of the room's interior atmosphere [3].

[1]Ishi et al. (2015) Analyses of Eye Fixation on the L-shaped Screen Layout in TV Programs, Bulletin of Sendai College of Technology, Natori Campus. 51,11-17
[2]Ishi et al. (2016) Effects of L-shaped Flash News Ticker on Watching Video, Transactions of Japan Society of Kansei Engineering. 15(7), 687-691
[3]Ishi et al. (2017) Effects of the Window View on Evaluations of a Room's Interior Atmosphere, Transactions of Japan Society of Kansei Engineering. 16(5) 473-477

Related Topics

・Kansei evaluation
・Gaze measurement

Network Learning System using Software Router and Network Simulator

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Affiliated Societies	Institute of Electronics, Information and Communication Engineers, Information Processing Society of Japan, IEEE
Keywords	Information network-related (60060) Educational technology-related (09070)

Research Topics

・Router model using a click modular router
・Interface between an NS3 network simulator and a learning system

Research Seeds

When students learn network technology, exercises are effective to understand the knowledge learned during lectures. However, experimental systems using hardware equipment are expensive for fundamental network exercises. This study implements fundamental network exercises on a low-cost PC by combining a software router "Click Modular Router (Click)" and a network simulator "Network Simulator 3 (NS3)."

An overview of the proposed network learning system is shown in Fig. 1. The system comprises an execution part and an interface part. When a learner inputs setup information of an exercise, the interface part generates setup files of the Click router using the setup information and the predefined configuration information. The NS3 program of the execution part simulates the exercise model by interpreting the setup file using Click modules. At the end of simulation, the interface part generates the output data from the trace result of simulation, and presents the result to the learner. A simple animation is also made from output data to show the network behavior visually to the learner.

We have implemented a prototype and a simple static routing exercise. Fig. 2 shows the input window of the exercise.
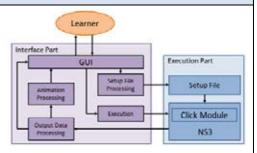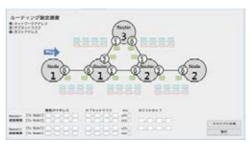
Fig. 1 Overview of Network Learning System.

Fig. 2 Input Window of Static Routing Exercise.

Related Technology

・Internet
・Software router
・Computer-based training

Next-Generation Communication Systems using Sound Localization

Satoshi YAIRI

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Affiliated Societies	Acoustical Society of Japan, Virtual Reality Society of Japan
Keywords	Virtual reality (61020), Experimental psychology in general (10040)

Research Topics

・Developing next-generation communication systems using sound localization
・Study of human ability to localize sound sources
・Improving virtual auditory display

Research Seeds

The main purpose of my study is to elucidate human auditory information processing and to develop comfortable communication systems based on human hearing properties. To realize them, interactions among auditory information, visual information, and self-motion perception (Multi Modality) are investigated.

One important tool in my study is the virtual auditory display (VAD). A perceived position of a sound image can be controlled by convolving head-related transfer functions (HRTFs) to the sound source. Systems of this kind are called a "virtual auditory display (VADs)."

To accomplish a high-accuracy VAD system, I investigated the following techniques:
• Presentation of a sound source responsive to the listener's head movement
• Choosing the best set of HRTFs
• Producing sound effects of reflection and reverberation

In VADs responsive to head movement, HRTFs are controlled by detecting the head movement with a position sensor. Therefore, the sound image does not move even if the listener moves. I developed Linux-based VAD software responsive to head movement [1]. The system latency of this system is about 12 ms.

This VAD system has been useful to assess the detection threshold (DT) against head movement [2] and characteristics of a listener's head movement during sound localization tasks [3].

Expressing an accurate three-dimensional sound image is possible using individualized HRTFs. Individualization features of Head-Related Transfer Functions based on subjective evaluation have been investigated [4].

[1] S. Yairi et al., Trans. Virtual Reality Soc. Jpn (in Japanese), 11(3), 437-446, 2006.
[2] S. Yairi et al., Applied Acoustics, 68(8), 851-863, 2007.
[3] S. Yairi et al., Acta Acustica united with Acustica, 94(6), 1016-1023, 2008.
[4] S. Yairi et al., Proc. of ICAD2008, June 24–27, 2008.

Related Technology

・Linux-based Virtual Auditory Display software responsive to head movement
・Signal processing to realize sound localization using Head-Related Transfer Functions

Energy harvesting of Low Density Energy Sources

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Professor	ishikawa@sendai-nct.ac.jp
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Keywords	Heat transfer, Energy conversion (19020) Solar energy utilization, Unused energy (36020)

Research Topics

・Design of heat exchangers
・Solar energy utilization
・Snow melting, combustion synthesis

Research Seeds

Characteristics of multi-fluid heat exchangers.

Most heat exchanger applications in process, air conditioning, refrigeration, and power industries involve transfer of thermal energy between two fluids through one thermal communication in two-fluid heat exchangers. Three-fluid and four-fluid heat exchangers are widely used in cryogenics and chemical processes. Different reasons might exist for bringing more than two fluids into thermal contact in different applications. Multi-fluid concepts of heat exchangers have possibility of becoming important merits of overall efficiency and space for processes.

The purposes of this research project are to provide comprehensive analysis and develop expression for various figures of merit of this special class of heat exchanger to help industries solve the problem of efficiency of multi-fluid heat exchangers on their unit operations.
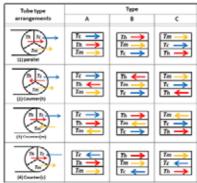
Fig. 1 Tubular type of three-fiuid heat exchangers and possible flow arrangement for plate type heat exchangers.
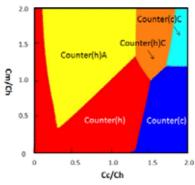
Fig. 2 Effect of various heat capacity rate and effectiveness for several type flow arangemet.

Related Technology

・Renewable energy
・Refrigeration and air-conditioning
・Heat engine

Simple Control Technique for a Geared Wheel Drive Systems Applied to Small Electric Vehicles

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Keywords	Mechanics and mechatronics-related (20010) Robotics and intelligent system-related (20020)
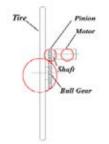
Research Topics

・Geared wheel drive system for a small electric vehicle
・Vibration suppression control of one-wheel geared-drive system
・Slip control for four-wheel drive system

Research Seeds

1. Slip Control for a Wheel Drive System
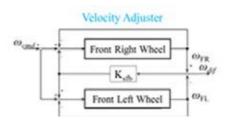
Fig. 1 Geared Wheel Drive System.

Fig. 2 Block Diagram of Slip Control System.

2. Simulation Results of Slip Control
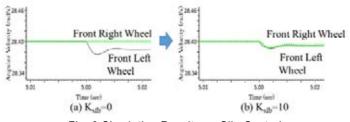
Fig. 3 Simulation Results on Slip Control.

A slip suppression control was proposed as an application to a four-wheel drive system. The effectiveness of speed compensation was verified. Slip suppression control using a speed adjuster is effective.

Related Technology

・Model-based control for suppression of the torsional vibration generated in a one wheel geared-drive system

The Mystery World of "Auditory Mechanics"

Shinji HAMANISHI

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Affiliated Societies	The Japan Society of Mechanical Engineering Japanese Academy of Budo
Keywords	Sports sciences-related (59020), Otorhinolaryngology-related (56050), Biomedical engineering-related(90110)

Research Topics

・Hearing loss by kendo players
・Development of sweep frequency impedance (SFI) meter
・Construction of finite element (FE) model of neonatal ear canal and middle ear

Research Seeds

・Impact-induced bone conduction simulation to ascertain the cause of hearing loss in kendo players

Kendo, Japanese fencing, is a modern martial art descended from swordsmanship. It is practiced widely in Japan, Korea and many other countries today. To get points and win matches, each player tries to hit one of the four target areas on an opponent's body with a bamboo sword.

Many reports on the subject of audiometry have described that kendo training over many years often causes sensorineural hearing loss at 2000 Hz and/or 4000 Hz. Although the risk of kendo-associated hearing loss has long been known, its mechanism remains unclear.

Our hypothesis is that the cause of hearing loss by kendo might possibly be related to accumulation of small concussions in the inner ear by the excessive impact-induced bone conduction. We evaluated this hypothesis using impact experiments with a skull bone model (Fig. 1) and simulation using a finite element (FE) model of a human head and a kendo helmet (Fig. 2).

Fig. 1. Experimental setup for bone conduction map using a skull bone model.
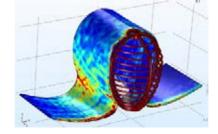
Fig. 2. Distribution of von Mises stress for Impact using FE model of kendo helmet.

Related Technology

・Measurement of microscale and nanoscale vibration using a laser Doppler velocimeter
・Measurement of otoacoustic emissions (OAEs)
・Measurement of auditory brainstem response (ABR)

Applying Real Time Calibration of Baseline Length in Single Camera Stereo Systems

Takashi WATANABE

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Affiliated Societies	IEEJ, JSPE, JSPE (IAIP)
Keywords	Measurement systems（21030）

Research Topics

・Machine vision
・Inspection system
・Motion capture

Research Seeds

3D image processing algorithms for real time calibration of the base line length in a single camera stereo system are presented in this paper. Performances of less than 0.03 mm depth measurement in precision and about 0.45 s processing time in inspection are also presented based on applications to the experimental equipment. It is technically noted that the baseline of this single camera stereo was calibrated precisely using the image processing procedure. This system of simple composition can expand the application range as a method of 3D measurement in an industrial field. To do this in our research, we propose an inspection environment for realizing an inexpensive and highly precise 3D measurement scheme and its algorithm.

Because stereo measurement has a simple system configuration, and because highly precise measurements are possible when the corresponding point information of the image is clear, wide utilization is advanced on various scenes such as use in an industry and security field. To realize the function of stereo views with one camera, a mechanism shown in Figure 1 was fabricated, where a camera is fixed and the work is set as movable along with the feeder. The left and right stereo images were captured at the respective moments before and after the mechanical feeder motion. The baseline was calculated precisely using corresponding feature points extracted from these two images. Some feature points are extracted precisely by the original algorithm for image processing.
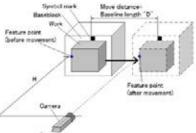
Figure 1. Single camera stereo model.

Related Technology

・Image processing
・Single camera stereo vision

Estimating Earthquake-Resistant Properties of Building Structures

Masayuki HANDO

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Affiliated Societies	Architectural Institute of Japan, Japan Society for Natural Disaster Science, Society of Architects and Building Engineers, Japan Concrete Institute
Keywords	Earthquake resistant design (23010)

Research Topics

・Measurement of building structure vibration
・Earthquake resistant analysis of reinforced concrete structures
・Maximum response displacement of a building structure during its serviceable period

Research Seeds

The author's research field is earthquake resistant design of building structures. Main activities are the observation of strong motion, response analysis during earthquake, and measurement of micro-tremors.   When the 2011 Off-the-Pacific coast of Tohoku Earthquake occurred on March 11, the earthquake and the ensuing tsunami killed many people. Moreover, damage to buildings from the earthquake was not noted and was soon forgotten because the damage caused by the tsunami was much greater and the nuclear power plant difficulties also became serious.   By contrast, the 2016 Kumamoto earthquake caused great damage to structures and provided opportunities to reconsider the power and risks of earthquakes.   Fig. 1 shows ground acceleration records for Sendai National College of Technology. Respective panels show the 20110311 (14:46) Off-the-Pacific coast of the Tohoku Earthquake (M9.0), the 20050816 (11:46) Off-the-Miyagi coast Earthquake (M7.2), the 20080614 (8:43) Iwate-Miyagi inland Earthquake (M7.2), and the 20110407 (23:32) Off-the-Miyagi coast Earthquake (M7.1).   Based on these records, the author has analyzed the relation between the index of failure property and actual damage. Fig. 2 presents an example of index.   The author has also measured micro-tremors in buildings for which strong motions were observed.   By comparing earthquake motion and micro-tremor data, the author has estimated the deterioration of buildings.   Fig. 3 shows the relation of natural period and the maximum amplitude of acceleration of motion.   Characteristics of a building before and after a strong earthquake are shown.   Research theme has properties of analysis rather than development.   The author hopes to predict causality between power exerted by nature and building damage.
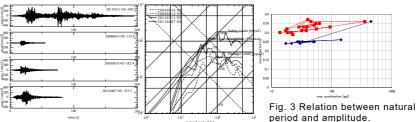
Fig. 1 Records of strong motions.

Fig. 2 Response spectrum.

Fig. 3 Relation between natural period and amplitude.

Related Technology

・Engineering for natural disasters

Measuring Indoor Air Flow Rates

Hiroshi KOBAYASHI

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Keywords	Architectural environment and building equipment-related Air environment (23020)

Research Topics
・Air-tightness of building
・Property of local opening
・Air flow volume of openings

Research Seeds

This study is intended to develop a method for determining properties of a local opening (i.e. equivalent area, airflow rate and flow exponent) based on results of fan pressurization tests on local openings for field measurements.

Equations for combination-separation of opening properties parallel-series placement are presented. Experimental investigations of the equation are performed using a test house and scale model.

Results indicate that applicability of the field measurement method of air flow rate for ventilation systems using the K-factor method is widened and the predictive precision of numeral calculation of the ventilation rate and CFD is improved.

Related Technology
・Fan Pressurization Method
・Numerical Analyses
・Field Measurement

Principles of Spatial Structures and Regional Characteristics of Okura-Syo in the Edo Period, Research on Preservation and Utilization of Historic Buildings

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Keywords	Architectural History (23040), Preservation (23040), Renovation (23040)

Research Topics

・Spatial structures of Okura-syo owned by the Kaga Domain during the Edo Period
・Research of historic buildings in Natori City

Research Seeds

My specialty is the History of Japanese Architecture. I am studying the Okura-syo, which was the most important facilities related to finance during the Shogunate and various feudal domains. The distribution facilities of Okura-syo used to store rice collected as a land tax paid by village residents. The rice was stored in the Okura and became "Kaimai." Many Okura-syo were built in Shogunate territory and territory of the various feudal domains. However, many Okura have disappeared (Fig. 1). I examined the building arrangement and the building structures of Okura-syo in areas where historical materials such as sketches were left. I clarified "The types of building arrangement, and the formation factors" of Okura-syo owned by the domain in the Tohoku Region or heavy snowfall area, up to the present day. The types of building arrangements differed by feudal domain. In addition, in the Kaga feudal domain, which had a large territory over three regions, the type of the building arrangement was different according to the region. I think that such Regional Characteristics of Okura-syo demonstrate the variety of the Edo Culture.

I established "The society to study of historic buildings in Natori City," in which I am acting as the representative. In cooperation with the board of education of Natori City, we clarified "The number of the historic buildings" and important historic buildings. Damage occurred to many historic buildings by the Great East Japan Earthquake. In Murata Town in southern Miyagi prefecture, damage occurred to the storehouses known as "Mise-gura." After the earthquake, the nation selected Murata Town for listing as a "Zyudenken-chiku (District for a group of important historic buildings)." Reconstruction of a cityscape thereby became difficult in Murata Town. Because of this, I made diagrams of restored buildings in Murata Town with computer graphics (CG). I am providing CG I had made, as shown in Fig. 2 to those local governments.

Fig. 1 Remains of Okura in Tottori.

Fig. 2 CG for the reconstruction of a cityscape.

Related Technology

・Research on historic buildings and evaluation
・Deciphering of ancient documents
・Making diagrams of a restoration using computer graphics

Developing Vibration Control Systems for Realize Safety and Functional Maintenance of Building Structures

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Keywords	Building structures and materials-related (23010)

Research Topics

・Development of a rocking pillar base isolation system suitable for masonry houses
・Development of new damper with inertial mass effects
・Elucidation of the damage mechanism of gymnasium building

Research Seeds

　Demands for buildings are diversifying, along with demands related to maintenance of building functions and other characteristics. My research themes are development of new vibration controls and a base isolation system to satisfy these demands.

　As a main research theme, I am studying the improvement of seismic performance of masonry houses in developing countries.

　Many people in developing countries must live, for technical and economic reasons, in traditional masonry houses of adobe, bricks, and concrete blocks. The M6.5 earthquake which struck Iran on December 26, 2003 destroyed the historical city of Bam completely, killing 40,000 people. The disaster reminds us that an urgent subject of earthquake engineering is to improve the seismic resistance of homes in economiccaly developing countries. Despite the risks posed by older methods of construction, it is not easy to shift the construction of these houses to that of modern technology because dependence on local masonry material products will not change. A possible solution for avoiding the collapse of the masonry houses is to implement base-isolation devices to reduce input acceleration by restricting the responding stress within the shearing strength of the masonry walls. To popularize base-isolation systems widely in economically developing countries, the system must be so simple that it can be manufactured at low cost and can be installed on-site by non-skilled local laborers. Considering those requirements, the authors have developed a new form based isolation system for masonry houses using a rocking pillar foundation.

Fig. 1 Isolation test specimen on shaking table.

Fig. 2 Analysis program (I made).

Related Technology

・Shaking table test
・Vibration response analysis

Developing Performance Evaluation Technology for Concrete in Cold Districts

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Keywords	Concrete (22010), Composite material (22010), Repair and rein-force material (22010), Structural material (23010), Maintenance (23010)

Research Topics

・Development of scaling resistance evaluation technique for concrete
・Evaluation of frost damage resistance using a rapid permeability test
・Development of a technology for improving concrete surface layer quality
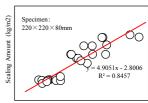
Research Seeds

In cold regions, concrete structures are adversely affected by frost damage caused by freeze–thaw action during extremely cold winters. In recent years, architects and civil engineers have observed that concrete structures often show scaling (Fig. 1): a phenomenon by which concrete surface layers delaminate. This phenomenon increases concomitantly with the spraying of antifreeze agents, composed mainly of sodium chloride (NaCl), onto road surfaces. In Japan, strict limitations on the use of studded tires from 1991 have engendered a rapid increase in the use of antifreeze agents to prevent road surface freezing. Consequently, concrete surfaces in cold regions are exposed to a severer chloride environment than ever. As a result, concrete scaling has become common because it is promoted synergis-tically by the compound action of chloride deterioration and freeze–thaw action. Currently, Japan has no established technique for evaluating concrete scaling resistance in a chloride environment.

Given this background, we conducted a study to de-velop a technique to evaluate scaling resistance in a chloride environment. We investigated the ASTM C672 and RILEM CDF scaling tests, which are widely used outside of Japan. We evaluated these tests from the ease of use and testing utility, and decided to endorse the application of RILEM CDF as a general-purpose testing method in Japan. To perform these scaling tests rapidly without the use of large facilities, we adopted a test method using a home freezer. As a scaling resistance evaluation technique for actual structures, we adopted a method using the air permeability of concrete as an index (Fig. 2).

Fig. 1　Scaling damage to concrete products.

Specimen:
$220 \times 220 \times 80$mm

$y = 4.9051x - 2.8006$
$R^2 = 0.8457$

Scaling Amount (kg/m2)

Air permeability Index: α (kPa/sec1/2)

Fig. 2　Relation between scaling amount and air permeability index: α.

Related Technology

・Quality evaluation and degradation diagnosis for concrete
・Technology for improving concrete frost resistance

Architectural Planning and Design Principles Based on Human Behavior and Living Needs

Yukari TSUKADA

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Keywords	Architectural and city planning-related (23030) Spatial planning (22050)

Research Topics

1. Spatial planning of school, play area, and facilities for childcare
2. Social systems and built environments in Finland for human-centered design.

Research Seeds

I have studied in multidisciplinary fields such as Housing and Environmental Design in Japan and City Planning in Finland. Furthermore, I have work experience as a teacher of home economics and as an ICT promoter in learning and education at school as well as an assistant architect in city government participating in two projects: creation of a new cultural multi-building in the center of the historical city, Osaka and maintaining signboards to easy visitors' travel.

My interest is creating child-friendly environments based on research and consultation, proposing comprehensive solution to contemporary issues related to physical environment in residential areas and buildings such as educational architecture and children's spaces.

【Research Topics】

1. Study of facilities for community-based after school care using private housing. Children use neighboring spaces and facilities frequently（Fig. 1）. Concepts of community-based facilities for afterschool care were drawn up.

2. Study of playground in Finland. To design children's play areas, we analyzed the relation between physical environment and children's behavior. Children's behavior is influenced by ground materials and landscape（Fig. 2）.

Fig. 1

Fig. 2

Related Technology

Lateral Buckling Capacity for H-shaped Beams Considering Restraint Effects on Non-Structural Members

Yuki YOSHINO

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Keywords	Steel structure (23020), Seismic engineering (23010)

Research Topics
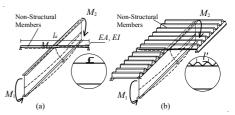
・Lateral buckling capacity for H-shaped beam considering effects of restraint for non-structural members

Research Seeds

Steel structures usually use H-shaped sections as structural members. H-shaped beams are connected by lateral braces in most cases, which is effective to prevent lateral buckling of the beams. Currently, Japanese design code only considers ideal cases in which a lateral brace is connected to a compressive flange or both flanges, by which lateral buckling is effectively prevented because it is initiated by flexural buckling of a flange under compression. However, considering that lateral braces are

Figure.1 Lateral Buckle for H-Shaped Beams.

usually connected to the upper flanges of H-shaped beams in moment-resisting frames, the upper flange at a bracing point can also be subject to tensile force, whereas the other (bottom) flange with no restriction is subject to compression under a combination of dead loads and lateral seismic loads. As a result, a beam can undergo lateral buckling deformation initiated by flexural buckling of the bottom flange.

Non-structural members such as roof purlin and folded-roof plates are not considered as lateral braces. They might not possess sufficient rigidity or strength to restrain lateral buckling deformation of H-shaped beams. Even so, non-structural members are expected to be effective to increase the buckling load of structural members to some degree.

When non-structural members are jointed to a beam, their connections are usually multiple but single and closely spaced, comparing with a lateral brace (structural member) supporting a beam. These closely-spaced multiple braces along a beam are conveniently defined as "continuous braces." Non-structural members, such as folded-roof plates, do not possess stiffness as large as a slab to restrain a beam from lateral buckling deformation. Some further evaluation is attempted to describe contribution of continuous braces.

This research examines the effectiveness of non-structural members as a lateral braces on the lateral buckling strength of H-shaped beams in a broader range of conditions in bracing stiffness and loading conditions.

Related Technology

Microstructural Control of Gas Nitrided Steel and Magnetic Materials

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Affiliated Societies	The Japan Institute of Metals and Materials The Magnetics Society of Japan The Japan Society for Heat Treatment
Keywords	Phase transformation (26010), Mechanical properties (26010), Surface treatment (26030), Social infrastructure materials (26040).

Research Topics

・Mechanical and structural properties of nitriding and nitrided quenching of the steel
・Magnetic and structural properties of the 3d transition metals
・Nanostructural control of the W-Cu composite alloys prepared using high-energy milling

Research Seeds

"New material development by ammonia gas nitriding treatment"

Nitriding treatment of metals such as steel forms a nitride layer on the material surface to improve corrosion resistance and wear resistance. This method has been widely applied, but fundamental research on nitriding processes, such as the formation of nitride with alloying elements and the influence on the nitride layer growth, is lacking. This research solves these difficulties and controls the surface hardened layer through nitriding and quenching of practical steel.

In addition, because the nitrogen penetrates into the metal as an interstitial atom in the metal, it strongly influences the magnetic properties of the 3d transition metal depending on the ambient environment. This research is conducted to stabilize the metastable phase such as fcc-cobalt by nitrogen solid solution and to create a new magnetic material.

"Nano-structural control of the W-Cu composite alloys"

W-Cu composite alloys are applied to the electrode and contact materials by excellent conductivity and abrasion resistance. Peeling because of the difference in thermal expansion coefficient, which is a shortcoming of this alloy, can be alleviated by microstructure refinement and homogenization. For this study, W-Cu alloy with ultrafine structure was produced using a converge mill capable of a large amount of pulverization treatment and using a hot press technique. The recovery rate of the finely processed powder is as high as about 90 vol.%. The powder microstructure consists of crystal grains of about 100 nm. The Vickers hardness of the sintered body produced by this processed powder, even though it contains 30% copper, is superior to that of the commercial product. It shows a value of about 90% of the hardness of pure tungsten. The sintering process consists of two stages of crystal grain growth and densification. It is possible to control the benefits of wear resistance and conductivity of the sintered alloy by controlling the sintering process conditions.

Related Technology

Optical microscope, X-ray diffraction method, pulverization technique (ball milling),
Hydrogen absorption technique, magnetization measurement (VSM),
Fluorescent X-ray analysis and transmitted X-ray observation,
Gas nitriding and heat treatment technique,
Vickers and micro Vickers hardness measurement, etc.

Formation Mechanism of the Synchronized LPSO Phase in Mg-Based Alloys

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Keywords	Mechanical properties (26010), Metals (30010)

Research Topics

・Formation mechanism of the synchronized LPSO phase in Mg-based alloys
・Local structures around small additive elements in alloys by XAFS measurements

Research Seeds

1. Formation mechanism of the synchronized LPSO phase in Mg-based alloys

A small amount of Y in Mg is effective to improve Mg strength. Furthermore, combined addition of transition element (T) with Y induces the formation of long period stacking order (LPSO) structure in Mg-T-Y alloy, which results in high yield strength. The LPSO phase in Mg-based alloy is known as a polytypic structure, but the thermodynamically stable structure has not been clarified. We reported that $Mg_{75}Al_{10}Y_{15}$ alloy has a thermodynamically stable new order structure (Fig. 1).
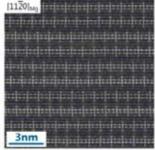
Fig. 1 New order structure in $Mg_{75}Al_{10}Y_{15}$ alloy.

2. Local structures around small additives elements in alloys by XAFS measurements

Alloys might greatly alter mechanical properties by the addition of other elements. However the measurement methods have a limit, so that the precise site occupancy of alloys of very dilute additives, such as those of ppm order, are difficult to ascertain. Measurement of the X-ray absorption fine structure (XAFS) using synchrotron radiation in the KEK and the SPring-8 can clarify the occupation position of very small amounts of additional elements. As presented in Fig. 2, we performed a XAFS investigation on the change of site occupancy of Nd and Gd in $Nd_2F_{14}B$ alloy during the HDDR process.
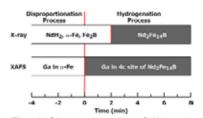
Fig. 2 Site occupancy of Nd and Ga in $Nd_2Fe_{14}B$ during the HDDR process.

Related Technology

・X-ray Analysis, Electronic Microscope
・XAFS

Improving Functional Metallic Materials Properties using Microstructure Control

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Keywords	Metallic material properties-related (26010)

Research Topics

・Improving workability and magnetic properties in NiMn-based metamagnetic shape memory alloys
・Improving of workability and magnetic properties in rare earth-free Mn-based permanent magnet materials
・Phase stability of Co-based Heusler-type shape memory alloys

Research Seeds

Because a large magnetic field-induced strain (MFIS) was reported for Ni_2MnGa single-crystalline alloy in 1996, ferromagnetic shape memory alloys (FSMAs) have received much attention as high-performance actuator materials.

Our group has identified an unusual type of FSMAs in Ni-Mn-X (X = In, Sn and Sb) based Heusler alloy systems, which show a drastic change of magnetization by martensitic transformation from the ferromagnetic parent phase to the very weak magnetic martensite phase. The martensitic transformation temperatures of these alloys are drastically decreased by an applied magnetic field, and the magnetic field induced transformation (MFIT), which is a kind of metamagnetic phase transition, has been confirmed in the martensite state near the martensitic transformation starting temperature *Ms*. Moreover, an almost perfect shape memory effect is induced by a magnetic field: the metamagnetic shape memory effect. Accompanying this martensitic transformation, giant magnetoresistance (GMR) and strong magnetocaloric effects (MCE) have also been reported. These alloys therefore show promise as new magnetic materials that are truly multifunctional.

However, the high cost of NiCoMnIn alloys due to expensive in and the brittleness of both NiCoMnIn and NiCoMnSn alloys in polycrystalline form are some of the major concerns for the insertion of these materials in practical applications.

Related Technology

・Melting furnace (Frequency induction melting, Arc melting)
・Magnetization measurement (VSM)
・Thermal analysis (TG-DTA, DSC)

Mechanical Behavior of Structural Materials

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Keywords	Strength of structural materials (18010), Hydrogen embrittlement (26040), Nitriding (26050),

Research Topics

・Development of log saw blades for tissue paper cutting
・Embrittlement of metals by gaseous hydrogen
・
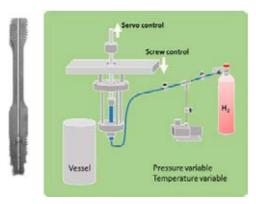
Research Seeds

Developed tissue paper log saw blades (see fig.1) with Toyo Knife Co. feature precise, clean cuts and extended cutting longevity. Introducing a new heat treatment process designed for high rotational speeds without edge vibration was brought from our latest research results of materials science and also vibration engineering (please see Dr. Hamanishi's page).
[Seeds: Materials processing for commercial steels:
(quench and tempering, nitriding, laser processing)]

Fig. 1 Log saw blade .

Hydrogen embrittlement is a complex phenomenon that affects a large class of metals. Our research group (NIT, Sendai and NIMS) uses novel testing method (see Fig. 2) developed by Dr. Ogata (NIMS) to evaluate the effects of gaseous hydrogen on mechanical properties of structural materials for hydrogen station and/or aerospace applications.

[Seeds: mechanical testing at various environments]

Fig. 2 Hydrogen embrittlement test system.

Related Technology

・Mechanical properties measurement system
・Laser processing machine

Developing Powder for Functional/Structural Materials and Microstructural Observation

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Keywords	Structural materials and functional materials-related (26040)	

Research Topics

・Synthesizing metal-based composites by mechanical alloying
・Structural analysis and microstructural observation using electron microscopy
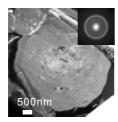
Research Seeds

1. Synthesis of metal-based composites by mechanical alloying

Figure 1 shows a cross-sectional TEM image of spherical fine β-FeSi$_2$ by a converge mill (CM). The selected area diffraction pattern in Figure 1 revealed that the powder consists of non-equilibrium phase involving nanocrystallite β-FeSi$_2$ [1]. Such direct synthesis of the spherical fine powder is difficult using other ball milling machines. The CM is a powerful, quick, and low-contamination process that can be applied to development of new functional materials and fine powder materials. Furthermore, we are studying mechanical properties of green compact.

2. Structural analysis and microstructural observation by electron microscope

The long-period stacking (LPS) type Mg alloy is attracting attention as a next-generation lightweight structural material. A new phase with a 10H-type LPS structure was found in an Mg$_{75}$Al$_{10}$Y$_{15}$ alloy annealed at 823 K [2]. Figure 2 shows a Cs-corrected STEM image and structural model of Mg$_{75}$Al$_{10}$Y$_{15}$ alloy. The bright dots in Figure 2 (d) correspond to Y atom. We clarified that an Mg$_{75}$Al$_{10}$Y$_{15}$ alloy has a highly ordered arrangement of L1$_2$ structural block consisting of Y and Al atom.
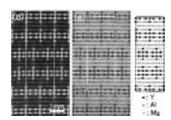
Figure 1   Figure 2

[1] M. Takeda et al., 16th International Microscopy Congress, Sapporo 1629 (2006)
[2] M. Takeda et al., Philosophical Magazine, vol.98 (2018) 2247-2256

Related Technology

・Synthesis of metal-based fine composite powders
・Structural analysis of materials using electron microscopy

Developing Novel Organic-Inorganic Hybrid Nanomaterials

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Keywords	Organic-Inorganic Hybrid Materials, Inorganic Nanoparticles, Colloidal Crystals, Small Angle X-Ray Scattering (28030)

Research Topics

・Development of liquid crystalline organic-inorganic hybrid dendrimers
・Quantum dot-based superlattices and their photoluminescence behavior
・Low-temperature sintering of metal nanoparticles

Research Seeds

Because of the rapid progress of nanotechnology in recent years, various synthetic methods related to nanoparticles and fine particles have been developed. Various nanoparticles suitable for application can be prepared easily. In the development of such nanomaterials, the contribution of the interface, which is a contact point between the material and the surrounding phase, becomes extremely large. The surface protective layer properties strongly affect the material functions. Therefore, to maximize the superior performance of nanomaterials, appropriate design for surface modification and structure, and precise control thereof are extremely important. Widely various knowledge related to interfaces is becoming necessary. In particular, studies of "organic-inorganic hybrid materials" that combine organic and inorganic materials having opposite properties to develop synergistic and associative functions, require more accurate functional predictions.

We have developed "Liquid-Crystalline Organic-Inorganic Hybrid Dendrimers" (Fig. 1) by hybridization of liquid crystalline organic dendrons and spherical inorganic nanoparticles to introduce self-assembling properties derived directly from dendrons into nanoparticles so that they spontaneously form a self-organized three-dimensional long period structure. Furthermore, precise design and synthesis of materials from the viewpoints of both organic materials and inorganic materials enable us to produce synergistic functional organic-inorganic hybrid nanoparticles such as low-temperature sintering metal nanoparticles and inks and polymer-grafted nanoparticles with miscibllity into resins and plastics. Nanostructure analyses are also characterized using transmission electron microscopy (TEM) and small angle X-ray scattering (SAXS).

Fig. 1 A schematic of "Liquid-Crystalline Organic-Inorganic Hybrid.

Related Technology

・Nanoparticle Syntheses
・Transmission Electron Microscopy (TEM)
・Small Angle X-ray Scattering (SAXS)

Microstructure of Oxynitride Thin Films

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Keywords	Ceramics (36010), Mechanical properties (26020), Crystal structure analysis (26020), Nanostructures (28030)

Research Topics

・Preparation of superhard oxynitride thin films
・Novel hardening technique of thin films by addition of elements

Research Seeds

Our research topic is hard coating materials for cutting tools, molds, and frictional components. We have mainly investigated chromium oxynitride (Cr(N,O)) thin films synthesized by partial replacement of N with O. The hardness of Cr(N,O) thin films increased with their oxygen content [1]. However, the hardening of Cr(N,O) could not be explained by the two main strategies (solution hardening and hardening by nanocomposite morphology). Recently, we found that the hardening of Cr(N,O) was caused by dislocation pinning at the boundaries of the nano-lamellar morphology [2, 3]. Findings of this work are expected to be applied as the design guideline for novel hard coating materials.
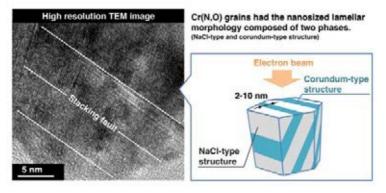
Fig. 1 Nano-lamellar morphology in the Cr(N,O) grain observed using high-resolution transmission electron microscopy.

[1] K. Suzuki *et al.*, *Mater. Trans.* **54** (2013) 1140.
[2] K. Suzuki *et al.*, *APL Mat.* **3** (2015) 096105.
[3] K. Suzuki *et al.*, *Thin Solid Films* **625** (2017) 111.

Related Technology

・Preparation of thin films by physical vapor deposition (PVD)
・Crystal structure analysis by X-ray diffraction (XRD)
・Crystal structure and microstructure analysis by transmission electron microscopy (TEM)

Environmentally Sustainable Electromagnetic Energy Convesion Systems

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Keywords	Electric machinery, Electromagnetic compatibility (21010), Renewable energy (64030), Unused energy (64050), Sustainable development (64060)

Research Topics

・Energy harvesting systems using renewable, unused, and sustainable energy
・Personal mobility systems (mainly power-magnetic systems)
・Smart grid and smart community engineering for sustainable development

Research Seeds

The main cause of global warming is human activity, which releases carbon into the atmosphere, most importantly the burning of fossil fuels to move cars, generate electricity, and operate our homes and businesses. Therefore, a transition is expected from a fossil energy society to a non-fossil (renewal, unused, and sustainable) energy society, and building a clean energy economy by investing in efficient energy technologies, industries, and approaches are expected.

- Investigating of small electrical power generators using renewable, unused, and sustainable energy.
- Evaluating designed electrical power generators and motors
- Evaluating of the experimental electrical power generators and motors.
- Investigating of the personal mobility systems and motor drives.
- Smart-communities with distributed power generator and smart transportation systems

Related Technology

Traffic Signal Light Color Discrimination for Road-Crossing Support of Pedestrians

Takashi SATO

Associate Professor	taksato@sendai-nct.ac.jp
Affiliated Societies	Information Processing Society of Japan
Keywords	Life assist technology (90150)

Research Topics

・Recognition of pedestrian traffic signals
・Object detection
・Visual system to help visually impaired or blind people
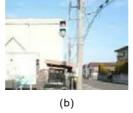
Research Seeds

In this study, methods by which visually impaired people can discriminate the color state of pedestrian traffic signals have been proposed. The method assumes situations in which one faces traffic signals and uses the crosswalk.

Pedestrian traffic signals in each frame image of video streams are detected using a Haar classifier with the AdaBoost learning process. To discriminate the light color of pedestrian traffic signals, only the brightness values of a centered pixel in each lamp device is used.

We used 16,209 frame images to evaluate our method. As a result, the respective correct discrimination rates were 99.7% for red traffic lights, 97.7% for green traffic lights, and 93.6% for the extinction of lights.
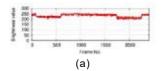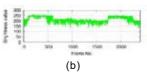
(a)   (b)

Fig. 1. Red (a) and green (b) pedestrian traffic signals.

(a)   (b)

Fig. 2. Coordinates of a centered pixel in each red (a) and green (b) light.

(a)   (b)   (c)
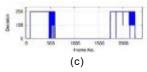
Fig. 3. Examples of video analysis results. Temporal variation of red (a) and green (b) light. (c) Results of color discrimination obtained from (a) and (b).

Related Technology

・Machine learning
・Image processing
・Feature extraction

Rugby Football

Naoto SHIBATA

Professor	naoto@sendai-nct.ac.jp
Affiliated Societies	Japan Society of Rugby
Keywords	Sports sciences-related (59020) Physical education and health education-related (59030)

Research Topics

・Rugby, coaching
・Education
・Leadership, communication

Research Seeds

・All game skills in rugby football
・Human education through rugby football

Related Technology

Social Skill Development in Physical Education

Takaaki FURUUCHI

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Affiliated Societies	Japan Society of Physical Education, Health and Sport Sciences, Japanese Society of Sport Education
Keywords	(1) Physical and health education (59030); (2) Physical education in school (59030); (3) Martial arts theory (59030)

Research Topics

・Effects of cooperative learning in physical education classes
・Establishing a new judo class method

Research Seeds

・Effects of cooperative learning in physical education classes

  Cooperative learning (CL) is effective to achieve physical, social, cognitive and affective domains. Five components are important for enforcement of the CL (Fig. 1).

1	Positive interdependence
2	Face-to-face interaction
3	Individual accountability
4	Social skill instruction in the interpersonal and small group
5	Reflection of the team activity and security of the improvement opportunity

Fig. 1 Component of the CL.

  My study is aimed at clarifying the improvement of physical and social domains in physical education class that apply a cooperative learning model. Specifically, I study the following points.

1. Making a unit based on questionnaire responses of class students.
2. Process of accepting roles in physical education classes that apply a CL model.
3. Improvement of physical and social domains in physical education.
4. Application method of CL suited to developmental stages.

・Establishment of a new judo class method

  In judo class, a student uses an iPad during group learning. When I set groups, I consider their judo experiences.

  Their skill improves by confirming movement using video and communicating with class members.

  In addition, I can expect the improvement of social domain such as communication and cooperation.

Related Technology

・Social skill development in classes that apply a CL model
・Establishment of a new physical education class method

KEYWORD INDEX

Hirose Campus
Natori Campus

Keyword (Medium Sized Section)
    Number   Keyword (Basic Section)   page

Human informatics

Environmental conservation measure

Biomedical engineering

< Note >
Grant-in-Aid for Scientific Research-KAKENHI- "Review Section Table" was used as the reference for producing the index above.

https://www.jsps.go.jp/j-grantsinaid/03_keikaku/data/h31/review_section_table.pdf

Technical Advisement・Joint Research・Commissioned Research

Sendai National College of Technology

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Technical Advisement

1. Application

2. Search and Introduction of adequate teaching staff

3. Advertisement to teaching staff directly [free (only once)]

Problem-solving !
or
to 2nd Advertisement and Joint Research, etc.

Joint Research・Commissioned Research

1. Application

2. Execution of Agreement

3. Payment of Research Expense or experimental Expense

Implementation

Company・Research Institution・Public institution・University etc.

Make mistakes・・・

Lose time・・・

I want to advance research with that teaching staff !

I want to ask questions and analyze instead, because I don't have analytical instruments !

Technical Advisement
To solve technical difficulties at companies, by utilizing our research results and technological knowledge, we support problem resolution and conduct technique guidance, give advise and share information to activate mutual research and development.

Joint Research
Research is conducted jointly by investigators as equals based on a common theme, by our receiving researchers and research expense from companies. Using the respective merits and conducted highly concentrated research, we can anticipate good results of originative applied development.

Commissioned Research
Under this system, companies commission their research themes to us with research expenses, we officially conduct research and report the results to companies (This is not a system of sending researchers out to companies.). This system is a major policy to share our teaching and research results with other institutions.
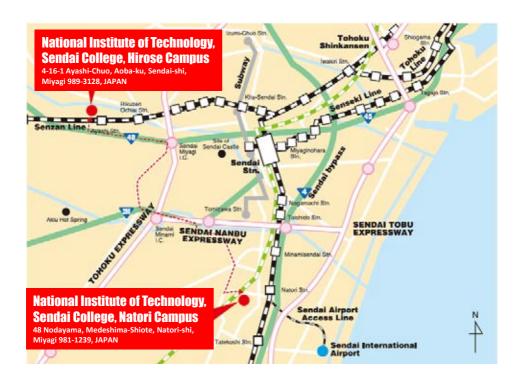
ACCESS

To Sendai Station

Tohoku Shinkansen (from Tokyo Station/ 92 min)
Sendai Airport Access Line (from Sendai International Airport Stn./ 25 min

To Sendai International Airport

Domestic: from Narita, Haneda, Nagoya (Chubu), Osaka (Itami)
International: from Seoul, Taipei, Guam and others

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National Institute of Technology, Sendai College, Natori Campus
48 Nodayama, Medeshima-Shiote, Natori-shi, Miyagi 981-1239, JAPAN

ACCESS

To Hirose Campus

From JR Ayashi Station:
・About 15 min on foot (about 1 km)
・It takes 25 min from JR Sendai Station to JR Ayashi Station by train.
・It takes 92 min from JR Tokyo Station to JR Sendai Station by Tohoku Shinkansen.

From JR Sendai Station Bus Pool:
・About 47 min by bus

From Sendai International Airport:
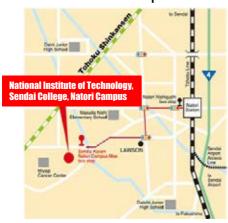・About 60 min by car

From Sendai Miyagi Interchange:
・About 10 min by car (about 6.5 km)

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To Natori Campus

From JR Natori Station:
・About 10 min by bus,
・About 25 min on foot (about 2.2 km)
・It takes 12 min from JR Sendai Station to JR Natori Station by train.
・It takes 92 min from JR Tokyo Station to JR Sendai Station by Tohoku Shinkansen.

From Sendai International Airport:
・About 30 min by car (about 15 km)

From Sendai Minami Interchange:
・About 20 min by car (about 10 km)

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