Tokyo Metropolitan University, Administration Office

TMU·Beyond

Introduction of TMU Research activities

Academia

Vol.1

Tokyo Metropolitan University is proud to present seven research centers.

Research Center for Space Science
Research Center for Genomics and Bioinformatics
Research Center for Artificial Photosynthesis
Research Center for Gold Chemistry
Research Center for Language, Brain and Genetics
Research Center for Water System Engineering
Research Center for Community Centric Systems

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TOKYO METROPOLITAN UNIVERSITY

Greeting from the President

Jun Ueno

At Tokyo Metropolitan University, our goal is to become a first-class university in terms of education and research, internationalism, and diversity, as is the duty of any institute of higher education. This goal is steadily becoming a reality.

The university has been highly commended for its research work, and we ranked 239th in the world in last year's Times Higher Education World University Rankings, making us one of the top ten universities in Japan—the seventh highest in the country. As for citations, we scored the highest possible score of 100.0 for the second year running, putting us in joint first place worldwide alongside Massachusetts Institute of Technology. It is definitely fair to say that, in terms of research prowess, we are among the top universities internationally.

The standard of the research carried out by each of our lecturers is extremely high, and they are all highly regarded in their respective fields. At Tokyo Metropolitan University, research groups that produce outstanding results and have the potential to become international research hubs, or those working in unique fields that are aligned with the university's mission, are designated as "research centers" and given support by the university.

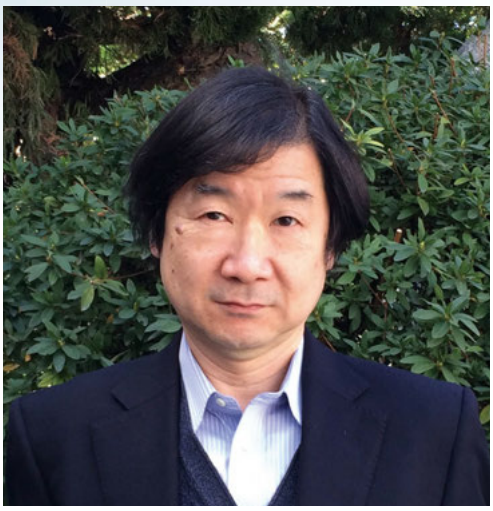
We aim to become a world-leading research hub, and have so far established seven centers, which will be introduced here: the Research Center for Space Science, Research Center for Genomics and Bioinformatics, Research Center for Artificial Photosynthesis, Research Center for Gold Chemistry, Research Center for Cognitive Neuroscience of Language, Research Center for Water Supply Systems, and Research Center for Community Centric Systems.

CONTENS

Research Center for Space Science

Six research groups from frontline fields cooperate to study the evolution of the solar system and the universe

Director of research center:
Professor **Takaya OHASHI,** ***Dr. Science***
Department of Physics,
Graduate School of Science and Engineering



■ Academic background

In recent years, space research has developed at a dazzling pace, as represented by the success of the space probe Hayabusa beyond expectation, and the awarding of the Nobel Prize in Physics for the discovery of the accelerating expansion of the Universe. Going beyond the limits of conventional space science, the field is rapidly expanding to embrace other peripheral fields, including particle physics and physical chemistry. Research exchange and close collaboration across a range of inter-related disciplines are becoming essential. Against this backdrop, with so many university groups engaged in space-related study, Tokyo Metropolitan University's Graduate School of Science and Engineering offers very strong potential to deepen linkages across specialist areas and to significantly extend this research capability. In terms of scale and research achievements, the Center is among the nation's leading space science research centers.

■ Innovative features of the Center

The most prominent characteristic of this research center is that it brings together six research groups active in areas related to space science—four from physics (experimental astrophysics, high energy physics, atomic physics, and theoretical astrophysics) and two from chemistry (cosmochemistry and physical chemistry)—as part of an effort to create a research facility of international recognition.

With its foundations as previous research activities of (1) the multidisciplinary exploration of the chemical evolution of the universe, and (2) the understanding of molecular science through ion storage rings, the center has a second characteristic: It is organized to facilitate effective research collaboration which goes beyond the boundaries between departments. Including research that makes use of JAXA satellites, there are many topics with promising future achievements, and a wide variety of results are beginning to emerge.

A third characteristic is Tokyo Metropolitan University's proximity to the JAXA Institute of Space and Astronautical Science, the center of Japan's scientific satellite program. This proximity provides field experience in a frontier environment where participants can join JAXA staff and graduate students in satellite observations and technical development experiments. This is an advantage offered by no other university.

Direct involvement in the program of two scientific satellites, Hayabusa 2, launched in December, 2014, and ASTRO-H, due to be launched within the research period, will enable us to obtain highly significant scientific achievements. A number of secondary benefits are also expected, including ground experiment of the solar wind charge exchange processes, particle physics experiments using accelerators and reactor neutrinos and theoretical understanding of the cosmic evolution.

Establishing the Research Center for Space Science as a research core will significantly enhance the University's profile, enabling the University to foster and send out into the field many highly qualified researchers and engineers.

■ The Center's vision for the future

We first expect to study and clarify the origins of the solar system and the process of its formation, based on the integrated information on the beginnings of the solar system obtained from radioactivation analysis of meteorites and asteroids, combined with optical and X-ray observations of solar system planets and exoplanets. A wide range of achievements are also possible, including the study of Galactic environment of cosmic rays, by combining the residual effects of cosmic rays in meteorites and X-ray and gamma-ray observations of supernova remnants; an understanding of the interaction between hot gases and neutral gases in space by comparing the charge-exchange cross-sections obtained from highly charged ion collision experiments and detailed X-ray spectra obtained from ASTRO-H; and the verification of an interstellar molecular ion formation model. Once the research period is complete, the Research Center for Space Science will continue to lead the study of unravelling the mysteries of the universe as an institute attached to the Graduate School of Science and Engineering.

X-ray Astronomy Satellite "ASTRO-H" ©JAXA

Hayabusa 2 ©JAXA

Achievements and awards

- Professor OHASHI: Awarded the PASJ Excellent Paper Award of the Astronomical Society of Japan four times (main author once, co-author three times). Has served as Director, etc., of Astronomical Society of Japan and project scientist of ASTRO-H
- Professor SUMIYOSHI: Director, Physical Society of Japan, Director, High Energy Accelerator Research Organization (KEK), Awarded 16th High Energy Accelerator Science Research Award.
- Professor TANUMA: Served as Permanent Secretary, etc., of Society for Atomic Collision Research in Japan (presently, Atomic Collision Society of Japan).
- Professor EBIHARA: Recipient of Geochemical Society of Japan Award, elected Fellow of Meteoritical Society, has served as President of Geochemical Society of Japan and Japan Society of Nuclear and Radiochemical Sciences.
- Professor SHIROMARU: Beam time assessment committee member, Grand Accelerateur National D'Ions Lourds (Heavy Ion Accelerator Research Institute), France, invited professor, Université de Caen Basse-Normandie (Caen University), France.
- Professor Masai: Director of Astronomical Society of Japan

Research Center for Genomics and Bioinformatics

Expanding the bio-infrastructure by nurturing frontline capabilities, starting with the development of key software in genome science development

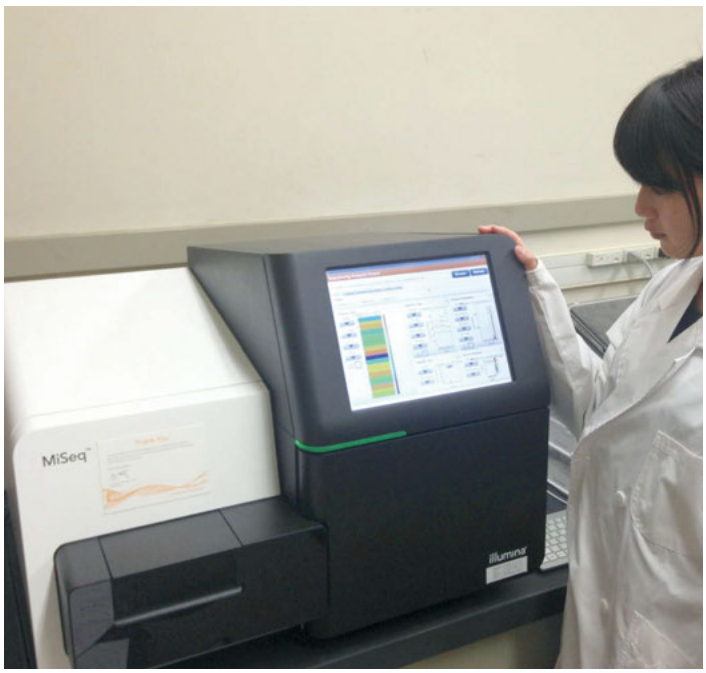
Director of research center:
Professor **Koichiro TAMURA**, ***Dr. Eng.***
Graduate School of Science and Engineering

■ Academic background

Since the first human genome was sequenced in 2004 through the post-genomic era of recent times, progress in DNA sequencing technologies has been astonishing. Hardware developments of high-throughput DNA sequencer have achieved a roughly tenfold improvement in efficiency over a span of two years. This figure outstrips the rate of progress forecast by Moore's Law in computer science, which states that computer performance doubles about every two years. To bridge the fivefold gap in speed of evolution that opens up every two years between sequencing technology and computation technology, it is becoming increasingly critical to address the challenge of the development of software (analysis methods and algorithms) and imperative to nurture the growth of young bioinformatician who is capable of leveraging the new software technology in data analyses.

In research specialized institutions equipped with next-generation DNA sequencers, there is no undergraduate students and a few graduate students to be trained. On the other hand, very few universities are equipped with next-generation DNA sequencers, leaving very few places where we can achieve both cutting-edge research and human resource development side by side. Tokyo Metropolitan University has taken the lead over other universities by introducing next-generation DNA sequencers, first in March, 2011, and then once again more recently in 2014, which are freely accessible by students for research and education.

Starting with the director internationally acclaimed in developing phylogenetic analysis software for molecular sequence data, the Research Center has a full complement of researchers involved in genome sciences and combines both the hardware and software required to develop human resources.



The next-generation DNA sequencer that is installed in the center.

■ Innovative features of the Center

The two special features of Tokyo Metropolitan University's Research Center for Genomics and Bioinformatics are (1) coverage of a wide range of research fields, with genome analysis positioned at the core, and (2) human resource development.

Unlike other research institutes, the Research Center installed at the University with many undergraduate and graduate students has the advantage of allowing a direct link to the nurturing of human resources well-versed in the very latest bioinformatics analysis technology.

Including core staff members Toshiro AIGAKI and Aya TAKAHASHI, both experienced in genome analysis and phenotype analysis and participants as planning team representatives, respectively, in the Ministry of Education, Culture, Sports, Science and Technology's Specific Area Research project of Genome Region and the New Academic Area Research project of Genome and Gene Correlations, our experienced staff establish the environment needed for an interactive approach to genome research.

Examples include the development of technologies linking genome to phenotype—the development and creation of new research on the analysis of the relationship between genomic information and phenotypes—and, as a new direction in genome research, the development of biodiversity research based on exhaustive genome analysis. These efforts will help generate academic ripple effects.

With the establishment of this Center, if interdisciplinary collaboration among researchers in related fields can be made concrete, this organization will become a center of research and education with international competitive strengths in genome science and other research fields based on bioinformatics techniques.

■ The Center's vision for the future

A mastery of software development technologies and operating techniques using high-throughput DNA sequencer will not only nurture and develop human resources with frontline skills in cutting-edge research, but those who can play a bridge role between different disciplines that require integrated capabilities in the areas of experimental biology and computational biology. By training and sending out into the world a number of outstanding human resources, the Center will enhance the University's profile and not only contribute to the development of a new research promotion system that combines ever-accelerating genome science with advances in bioinformatics, but make significant contributions to medical fields and to humanity as a whole.

Establishing collaborative relationships with the Bioinformatics Institute, A*STAR (Singapore) and Temple University (USA) is highly significant in our efforts to train bioinformatics researchers with an international perspective.

Our joint research program with Temple University will continue to grow stronger, and MEGA, the internationally acclaimed molecular phylogenetic analysis software, is currently undergoing further development.

Achievements and awards

- Professor AIGAKI, Associate Professor TAKAHASHI: Genome analysis, phenotype analysis as planning team representatives, the Ministry of Education, Culture, Sports, Science and Technology's Specific Area Research project of Genome Region and the New Academic Area Research project of Genome and Gene Correlations.
- Director Frank Eisenhaber: Functional analysis utilizing sequence data.
- Associate Professor HARUTA: Exhaustive genome analysis of environmental microbe groups.
- Assistant Professor KATO: Research of genetic diversity of plant life in Bonin islands.
- Professor OKABE, Dr. Hwee Kuan Lee: Phenotype analysis, etc.

Research Center for Artificial Photosynthesis

For realizing artificial photosynthesis as a third-generation new energy system with zero CO_2 emissions

Director of research center:
Professor* Haruo INOUE, *Ph. D.
Department of Applied Chemistry,
Graduate School of Urban Environmental Sciences

■ Academic background

The global environment and future prospect of energy for humankind pose serious issues. Along with the depletion of fossil fuel resources, the rapid increase of carbon dioxide in the atmosphere is becoming a serious concern for rapid climate change. It should be recognized that the creation of new types of energy without emitting carbon dioxide is a top priority for a sustainable society. Artificial photosynthesis as one of the most promising sustainable sciences or technologies; it mimics natural photosynthesis using sunlight, carbon dioxide, and water to create chemicals that become fuels and useful materials and thus has been a dream of mankind. While the solar energy shining on the Earth is relatively diffuse, and its intensity varies significantly depending on the region, season, and time of the day, its total amount is nevertheless ca. 10,000-fold larger than the energy currently consumed by mankind. It should thus be the most promising resource for the next generation of energy production. Even though the practical application of photovoltaic solar cells as a second-generation energy system could be an urgent target to be realized for the immediate future, with simultaneous development expected in power storage technologies, it is imperative to build new energy systems, i.e., artificial photosynthesis as a third-generation energy system that will convert and store solar energy into chemical energy (material), together with electrical energy, allowing extraction of the required energy at the required time.

■ Innovative features of the Center

Artificial photosynthesis research covers broad fields such as biology, biochemistry, molecular biology, chemistry, photochemistry, materials science, physics, engineering, and computational science, among others. Science in Japan has thus far been producing substantial contributions in the fields of (1) natural photosynthesis, (2) artificial photosynthesis by means of organic and metal-complex systems, and (3) artificial photosynthesis catalyzed by semiconductor systems.

In the area of artificial photosynthesis based on organic compounds and metal-complexes, the Inoue research group at Tokyo Metropolitan University has discovered an original method for the two-electron activation of water using a single photon excitation, attracting much attention because of its unique approach as one of the most promising breakthroughs to get through the bottleneck of water oxidation in artificial photosynthesis.

The Center will continuously contribute to general society through its active presentation of its achievements in artificial photosynthesis research, which represent part of the academic assets of the University.

■ The Center's vision for the future

Based on their original idea, the Inoue research group has discovered a series of new sensitizers, i.e., reaction systems composed of new artificial photosynthetic reaction centers, using ubiquitous earth-abundant elements. By collaborating with groups like the Masuda group currently at work on creative research in the field of nano-hole-array-device materials, the research group is taking on the challenge of constructing an artificial photosynthetic system.

Practical application of those systems in general society with a target date of around 2050 will require long-term sustained efforts. To achieve zero CO_2 emissions in the time scale through the transition from second-generation renewable energy to third-generation artificial photosynthesis, the Center will strive to pass the baton to its young researchers. We plan to push our research through three stages—(1) pure basic research, (2) goal-oriented basic research, and (3) developmental research—then place our science and technology proposals on the public stage for selection by society, after which we will undertake (4) technological development and (5) demonstration experiments. Some of the concepts associated with these processes have already been incorporated into Japan's basic science planning, green innovations, and life innovation planning. As a global center of excellence, through our collaborations with other countries, universities, and research organizations, we will realize a University that is in good resonance with general society through innovations in science and technology.

2014 International Conference Artificial Photosynthesis (ICARP2014) in Awaji Yumebutai International Conference Center.

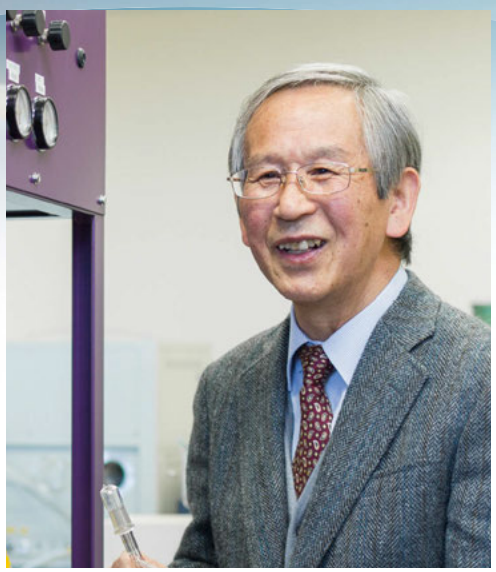
Achievements and awards

- Professor INOUE: Leading the CREST and SORST project on "Construction of artificial photosynthesis system with water an electron donor" as the research representative. Research supervisor of "Chemical conversion of light energy" at the Japan Science and Technology Agency (PRESTO), area leader of a Grant-in-Aid new science and technology area on "Artificial photosynthesis" under the auspices of MEXT Japan. Organizing the International Conference on Artificial Photosynthesis (ICARP) 2014. Served as the chief Vice President, the Chemical Society of Japan; President, Japanese Photochemistry Association; President, Asian and Oceanian Photochemistry Association; Vice President, Japan Union of Chemical Science and Technology; liaison member, Science Council of Japan, etc.
- Professor MASUDA: Has gained worldwide acclaim for work in explaining the structure of anodized aluminum film and its applications to nano-device materials. Publication of a nano-hole array article in Science. Group leader of priority research at Kanagawa Academy of Science and Technology, etc. Foremost expert on nano-hole arrays involving anodized aluminum film.
- Professor TAKAGI: Researcher on materials science and photo-functional chemistry. Discoverer of original size-matching effects in molecular chemistry using nano-layered compounds.
- Professor TACHIBANA: Collaboration with Professor Inoue and others from a theoretical chemistry perspective, with significant contributions in the forecast and design of artificial photosynthesis reaction centers.
- Assistant Professor SHIMADA, Assistant Professor NABETANI: Experts in ultrafast measurements and contributors to photochemical reaction analysis up to the femtosecond region, ultrafast analysis of primary processes of nano-hybrid materials in supra-molecular microenvironments and probe-microscopy technology.

Research Center for Gold Chemistry

Aiming at creating new functionality by fusing gold and biotechnology

Director of research center:
Professor **Masatake HARUTA,** ***phD***
Department of Applied Chemistry,
Graduate School of Urban Environmental Sciences



■ Academic background

Gold is an extremely stable metal and, until the 20th century, was generally considered to be chemically inert. However, in the course of more than thirty years of study by leading researchers, we have learned that by depositing gold nanoparticles of 2–5 nm in diameter onto a base metal oxide, carbon monoxide can be oxidized even at low temperatures, such as -70°C, revealing the existence of a rich chemistry within gold. In particular, gold nanoparticle catalysts are expected to find applications in environmental purification technologies. Room-temperature chemical reactions previously considered not possible with conventional catalysts have applications in air and water purification. Meanwhile, research on the catalytic performance of gold nanoparticles and gold clusters and on their applications in medical diagnosis and treatment has increased significantly. Based on the increase in the number of papers on gold catalysts (from around 10 in the 1980s to more than 1,000 annually at present), interest in gold catalysts has clearly and dramatically increased.

With the successful conclusion of the 6th International Conference on Gold Science, Technology and its Applications, hosted by Tokyo Metropolitan University in 2012, the University has gained a global reputation as a center for research on the chemistry of gold. The Kick Off Workshop for the Research Center for Gold Chemistry held in May 2014 was attended by distinguished experts in gold from around the world. From these beginnings, across a wide range of dimensions, we at this Center will continue to lead the world in drawing a comprehensive picture of the chemistry of gold, with its many and various micro-structures.

■ Innovative features of the Center

Since no other research center in the world focuses on the chemistry of gold, this is a unique field of research in which the University can build a global profile. In particular, the Center's world-leading trials in creating new functionality from the combination of gold and biotechnology are unique and highly original. A patent application has already been filed for a technique for the oxygen oxidation of glucose in a neutral aqueous solution by combining a gold nanoparticle catalyst and an enzyme catalyst, glucose oxidase. This hybrid system is part of our basic concept. This new field of gold nanoparticle catalysts is already recognized worldwide, and, in the future, as the next phase, we will move to advanced medical technology and develop nanomedicine by fusing gold-based nanotechnologies with disciplines such as medicine, life sciences, and biology. While five years is too little time to initiate original research and demonstrate positive results, we expect new frontiers of research be developed in the fields of gold chemistry and in the materials science of metal clusters.

■ The Center's vision for the future

The Center focuses on gold nanoparticles and clusters. Our goal is to establish the field of green chemistry, a pressing issue for modern society. Our innovative research involves various challenges: first, the three dimensional structural analysis and surface chemical properties of gold clusters; second, a simple chemistry that does not waste resources and energy and does not create superfluous by-products; third, the synergies between man-made gold nanoparticle catalysts and bio-catalyst, enzymes; and fourth, the study of the pharmaceutical action of gold clusters and their applications to the synthesis of medicines without side effects. Achieving these goals will require a personnel structure spanning many different faculties and departments, and, in addition to securing the necessary staffing, we will promote Tokyo Metropolitan University worldwide, as we move forward to pursue growth and development into a cluster research center. If free and flexible research investment in this Center is made possible, the Center has a high potential of becoming a global center for gold and cluster research.

Opening ceremony for the Frontier Research Building:
Key facilities for Research Center for Gold Chemistry.

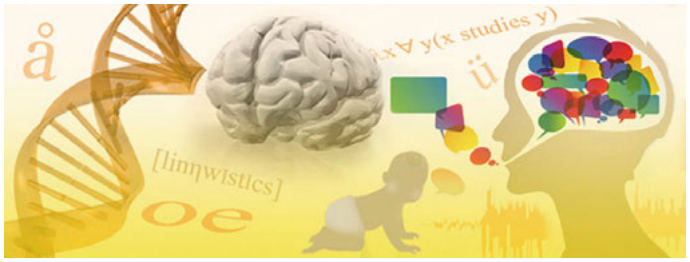
Achievements and awards

- 2009: Foreign member of the Academia Europaea
- 2010: CSJ Award by the Chemical Society of Japan for novel catalysis by gold nanoparticles.
- 2011: Spiers Memorial Award by the Royal Society of Chemistry for pioneering work in gold chemistry and the creation of the new field of catalysis by gold.
- 2012: Visiting Professor for Senior International Scientists by Chinese Academy of Sciences
- 2012: Thomson Reuters Citation Laureate for unique and fundamental discoveries of catalysis by gold; nominated as a leading candidate for the Nobel Prize in Chemistry.
- May 2014: Honorary doctorate (Docteur Honoris Causa) by Université Catholique de Louvain. 67th Chunichi Culture Award by Chunichi Shimbun for the discovery of the catalysis by gold.

Research Center for Language, Brain and Genetics

Elucidation of innate language faculty and their application to language education and clinical practices, using integrated research of language, brain and genetics

Director of research center:
Professor **Hiroko HAGIWARA**, ***Ph.D. in linguistics***
Department of Human Sciences,
Graduate School of Humanities



■ Academic background

Language is one of the higher-order cognitive functions of the brain, seen only in humans, and is a genetically determined attribute. Research into so-called "the language faculty" has recently made dramatic developments, as seen in the rapid progress of neuroscience in recent years and the discovery of FOXP2, a gene that appears to be associated with speech and language abilities. Research themes are no longer limited to conventional theoretical linguistics (the theory of generative grammar), but are spreading rapidly by bringing in other related fields such as linguistic neuroscience, biolinguistics and genetics. Research exchanges and close cooperation among a variety of associated fields are becoming increasingly essential in the study of language function.

Tokyo Metropolitan University, centering on the Department of Language Sciences in the Faculty of Human Sciences, has a large number of researchers engaged in the study of language/cognition and the brain, as well as genes. The primary aim is to collaborate and bring together studies related to language function, using three different approaches—linguistics, neuroscience and genetics—to produce ever more advanced research results.

■ Innovative features of the Center

The Center has several unique characteristics. The first is its ability to make use of its geographic advantage—that of being located in the Tokyo metropolitan area— to form strong collaborative setups and partnerships with diverse research institutions, including the RIKEN Brain Science Institute (BSI) which serves as the center of brain science research in Japan.

The second is that the Center's organizational setup is designed to ensure that effective collaboration takes place among various participating researchers that transcends their areas of specialty, based on research funded by external sources.

The third, and chief, characteristic is that it will become the world's first research center that comprehensively handles language, the brain and genetics within a framework of life sciences. With a total of fifteen staff members comprising five groups that span the fields of linguistics, the brain and genes, all related to language function, we will build the only research base of its kind which will no doubt earn international acclaim both in terms of its scale and research achievements.

Numerous ripple effects are being envisaged, besides the fostering of young researchers. We will use the techniques of genome-wide association study (GWAS) and population-genetic analysis to identify language-related genes; build new models of human language functions and establish a language-acquisition theory; elucidate the relationship between language acquisition and brain development; and explore the neural basis of language processing including phonology, syntax, semantics and pragmatics by using brain imaging devices, such as electroencephalography (EEG), that excel in temporal analysis.

■ The Center's vision for the future

Genetic analysis of the degree of achievement of learning and language acquisition will be used to devise tailor-made learning and teaching methods to suit the individual, making efficient acquisition of a second language a reality. Elucidation of language-related genes will lead to the development of new methods for diagnosing language impairment and developmental disorders, based on objective medical evidence.

Elucidation of language-related genes in humans enables comparisons with homologous genetic sequencing of animals, resulting in the promotion of animal research and the creation of a new field of study, "the bioscience of the human language learning function". We can gain new perspectives and knowledge by elucidating processes that "cannot be verbalized" seen in children during adolescence, such as violence, withdrawal from society, and suicide, by collaborative efforts with the Tokyo Teen Cohort Study, a project conducted by the Tokyo Metropolitan Institute of Medical Science, from the perspectives of behavioral science, neuroscience and genetics.

With these future outcomes as our aims, we will employ researchers in genetic science that links animals and humans, and further strengthen our setup to promote gene research. At the same time, we will collaborate, on a long-term basis, with the Tokyo Metropolitan Institute of Medical Science's cohort study.

Achievements and awards

- Professor Hiroko Hagiwara: Received the Sanki Ichikawa Award and the Outstanding Paper Award of the Japanese Cognitive Science Society; Member, the Special Committee, School Curriculum Section, Central Council for Education of the Ministry of Education, Culture, Sports, Science and Technology, etc.
- Associate Professor Fumitaka Homae: Received the 18th Young Investigator Award of the Nakayama Foundation for his research on developmental neuroscience relating to infants' speech perception. Has published over 30 scientific papers.
- Associate Professor Ryuichiro Hashimoto: Specializes in functional imaging methods in neuroscience of language and social neuroscience. Was engaged in the study of clinical neuroscience, focusing on developmental disorders, at U.S. research institutes. Has published over 30 papers in international science journals.
- Professor Yoshiaki Kikuchi: Received the Outstanding Presentation Award, Japan Society of Physiological Anthropology; Outstanding Award, Japan Academy of Health Sciences; Best Paper Award, the Japanese Association of Rehabilitation Medicine, etc.
- Professor Kuniyasu Imanaka: Member, Special Committee, Committee on Grants-in-Aid for Scientific Research, Japan Society for the Promotion of Science; Member, Special Committee, Committee for National University Education and Research Evaluation; Auditor, Japanese Society of Sport Psychology, etc.
- Professor Toshiro Aigaki: JST Sakigake 21; Planned research on priority areas of the Ministry of Education, Culture, Sports, Science and Technology; NEDO; Tokyo Metropolitan Leading Project, etc.
- Takeo Yoshikawa, Senior Team Leader: Director, Japanese Society of Biological Psychiatry; Council Member, Japanese Society of Schizophrenia Research; Council Member, the Japan Society of Human Genetics; Council Member, Japanese Society of Neuropsychopharmacology, etc.
- Atsushi Nishida, Project Leader: Has led one of Japan's largest-scale mental health epidemiological surveys. He currently leads Japan's first teen cohort study.

Research Center for Water System Engineering

Realizing next-generation water supply systems that leverage expert systems, new ICT technologies, etc. to handle maintenance and management

Director of research center:
Professor* Akira KOIZUMI, *Dr. Eng.
/ Professional Engineer (water supply and sewerage)
Department of Civil and Environmental Engineering,
Graduate School of Urban Environmental Sciences

■ Academic background

Forty years have passed since the construction of the water supply facilities rapidly developed and deployed during Japan's period of high economic growth, and many of these facilities are now approaching a period of deterioration due to age. Today, the water supply system is recognized as an uninterruptable lifeline, available anytime, anywhere, and consumer need for "safe, delicious water" continues to grow day by day.

However, as urbanization advances, in addition to the difficulty of securing good quality water sources, a delay in adequate maintenance management and preventive maintenance due to financial difficulties raises the risk of incidents that may interrupt the water supply and degrade water quality.

Beyond praise within domestic industry circles for world-class water supply technologies and for numerous research achievements presented at IWA (International Water Association) international conferences and awards, Japan makes broad contributions as an advanced water supply nation to the world's end users.

The Center takes a leadership role in industrial-government-academia joint research focusing on water systems and is currently establishing a powerful human network of academics, water supply operators, and private sector companies nationwide.

From the broad perspective of an industrial-government-academia joint system, in our capacity as a think tank for many of Japan's water supply corporation, and as a center for technologies promoting the development of water supplies across the countries of Asia, our goal is to develop and promote a future vision for next-generation water supply systems to ensure the maintenance of sound water supply facilities and high quality water supply.

■ Innovative features of the Center

With water supply coverage already quite high, as with other public utilities, in addition to improving efficiency and reducing power consumption, today's challenges include passing on related technologies in the face of dwindling numbers of technicians.

As technological development advances in terms of hardware—for example, in the introduction of advanced water treatment and improvements in water distribution facilities—further advances are needed in developing non-hardware planning techniques.

The Center targets next-generation water supply systems for both the complex and high density water supply systems in Tokyo's 23 wards and the small- to mid-scale water supply systems of the Tama district and the remote islands, by collating into big data information accumulated on-site by highly experienced engineers from comprehensive research grounded in systems analyses, modelling development along spatial and temporal axes, and underpinning these efforts with data control using expert systems established through data mining, planning decisions that leverage optimization theory, and development of overall evaluation indicators.

A research community of this type, enabling the development of a comprehensive research methodology whose vision encompasses the spectrum from the water source to the tap, is unique, even on the global stage. Through development to levels that account for local characteristics, we can diffuse applications not only within Japan, but throughout Asia and many other regions. This constitutes a major academic advance, even at the international level.

■ The Center's vision for the future

Given the current status of water supply facilities, it is now possible to implement a certain degree of automation by using man-machine systems to impart visibility to specific technologies and tacit knowledge and transform them into explicit knowledge, as well as to realize the development of simulators that can be used to train technicians. From a preventive maintenance perspective, given the situation today in which preventive maintenance after the fact is not acceptable and cyclical updates will become an important issue moving forward, the Center will disseminate widely the importance of a proactive approach to maintenance management, and starting with the development of technologies that can diagnose the health of water supply systems, realize the creation of a water supply system that leverages new information and communication technologies (ICT) through a joint industrial-government-academia multifaceted system.

Deploying the Center's research results for water supply workplaces throughout the country will involve the development of long-term joint research efforts with the Tokyo Metropolitan Government Bureau of Waterworks and national research facilities. In addition to continuing with multifaceted advances in research cooperation and student exchange with the University of Seoul, plans target advances in the construction of research exchange systems with universities mainly in Asian countries like Vietnam, Indonesia, and India.

Seoul Tokyo forum 2014

Achievements and awards

- Awarded Project Innovation Award in East Asia for e-Pipe Project from IWA.
- Awarded Japan Waterworks Association Merit Award (Best Paper Award).
- In recognition of continued service as chairman in Japan Water Works Association's special symposia and research presentations, awarded prize for 20 years of service as chairman in 2014.
- Has served as chairman on major projects related to water piping technology comprising industrial-government-academia engineers and scholars at the Japan Water Research Center since 2002.
- Invited to many water supply related international conferences in South Korea and other countries to give lectures.

Multi-faceted application of robots and big data opens up promising futures for disaster prevention, welfare, and nursing care for the elderly

■ Academic background

Disaster prevention remains a central issue as Tokyo prepares for the 2020 Olympic and Paralympic Games, and expectations are growing daily for progress in "community centric" research applying robots and IT in multifaceted ways. The term "community centric" refers to a new international trend that will be realized by the acquisition of user logs through social robotics (ROB) as informational media, the multifaceted analysis and creation of user models by leveraging the social big data acquired, and further, the support implemented by multiple matching for a whole community that comprises multiple users. Disaster prevention community research is a representative topic in this field.

With the number of elderly people living alone in the Tokyo metropolis expected to exceed three million in 2015, the issue of welfare and nursing care for the elderly is emerging as a major challenge. Resolving this issue will require consideration of intelligent housing and other forms of green innovation (GI) and progress in smart QOL based on a focus on life innovation (LI) that makes QOL (quality of life) reality.

At the Center, in addition to disaster prevention community research underpinned by both the social ROB as informational media at the international research level and the leveraging of social big data, we also pursue community centric foundation research from a global perspective, extending to community support for smart QOL and other fields of health, welfare, and nursing care. One example is the construction of mobile trailer homes incorporating artificial intelligence functions. Typically, these homes can be operated as community facilities, performing data collection for local residents, then used to exchange the data needed by users in times of emergency.

■ Innovative features of the Center

The special characteristic of this Research Center is that it focuses on both the acquisition of user logs via social ROB and the leveraging of social big data. Other unique points are the makeup of our research staff, recruited to reflect the needs of globalization and diversity; our disaster prevention community research; and the application of actual data from real fields directly linked to welfare and preventive care for the elderly.

Additionally, the development of our research is accelerating through the patent "Techniques for publishing big data using advanced new technology while avoiding personal information leaks."

Secondary benefits include the disaster response robot industrial agglomeration support project that take advantage of our research results, the launch of a refugee assist robot system to regenerate communities that have suffered unprecedented loss and damage in the Great East Japan Earthquake, and its development into the Social Robot Network Service (SRNS).

■ The Center's vision for the future

The gathering of log information, which forms the infrastructure foundations, the use of social big data, and the development of sophisticated social big data created from data mining will lead to breakthroughs in many of the problem areas currently facing major cities in disaster prevention, welfare and nursing care for the elderly, tourism, shopping, and food and drink.

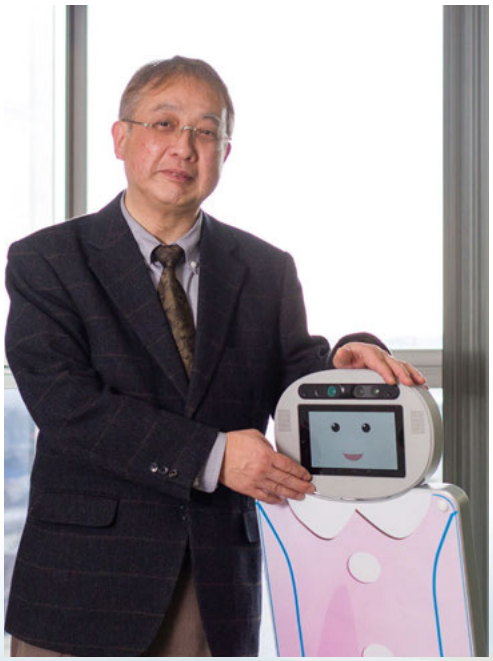
The sharing and joint use of this data will heighten the Web reputation among users and academic appraisal parameters such as citation frequency. By encouraging personal independence and motivation and the motivation to communicate with others, robots, rather than taking over human labor and reducing human burden, will create a future through wide-ranging contributions to society.

The management of city-related foundation data will continue into the distant future, and this Center will work to create systems that promote research featuring expanded collaboration between an international research platform for the information science fostered by the Center and departments dealing with real urban issues, thereby becoming the nucleus of an internationally renowned SRNS.

Mobile community space MOBIPO

Achievements and awards

- Disaster response robot industrial agglomeration support project
- JST Sakura Science Plan
- Professor YAMAGUCHI, Professor KUBOTA: JST PRESTO pioneer research "Interaction and Intelligence", NEDO 21st Century Robot Challenge Intelligence Technology PJ, etc. The term "community centric" was submitted to IEEE by this research group as a whole, and accepted. Several IEEE-related international conferences held.
- Associate Professor ICHIKO: Regional disaster prevention unit chief, research achievements in creating regional disaster prevention communities.
- Professor NITTA: Chief examiner, school-wide inclination research of smart QOL. Many research achievements in the field of health and welfare and nursing care.
- Associate Professor TAKESUE: Many achievements in intelligent systems (mechatronics).
- Professor KIYA, Assistant Professor SHIOTA: Many awards in their respective fields.



Director of research center:
Professor **Toru YAMAGUCHI**, ***Dr. Eng.***
Graduate School of System Design

Research Center for Space Science

OHASHI Takaya, Professor	Graduate School of Science and Engineering, Dept. of Physics
ISHISAKI Yoshitaka, Associate Professor	Graduate School of Science and Engineering, Dept. of Physics
EZOE Yuichirou, Associate Professor	Graduate School of Science and Engineering, Dept. of Physics
YAMADA Shinya, Assistant Professor	Graduate School of Science and Engineering, Dept. of Physics
SUMIYOSHI Takayuki, Professor	Graduate School of Science and Engineering, Dept. of Physics
KAKUNO Hidekazu, Associate Professor	Graduate School of Science and Engineering, Dept. of Physics
KUMITA Tetsuro, Assistant Professor	Graduate School of Science and Engineering, Dept. of Physics
TANUMA Hajime, Professor	Graduate School of Science and Engineering, Dept. of Physics
FURUKAWA Takeshi, Assistant Professor	Graduate School of Science and Engineering, Dept. of Physics
MASAI Kuniaki, Professor	Graduate School of Science and Engineering, Dept. of Physics
SASAKI Shin, Assistant Professor	Graduate School of Science and Engineering, Dept. of Physics
EBIHARA Mitsuru, Professor	Graduate School of Science and Engineering, Dept. of Chemistry
OURA Yasuji, Associate Professor	Graduate School of Science and Engineering, Dept. of Chemistry
SHIRAI Naoki, Assistant Professor	Graduate School of Science and Engineering, Dept. of Chemistry
SHIROMARU Haruo, Professor	Graduate School of Science and Engineering, Dept. of Chemistry
MATSUMOTO Jun, Assistant Professor	Graduate School of Science and Engineering, Dept. of Chemistry

Research Center for Genomics and Bioinformatics

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AIGAKI Toshiro, Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
TAKAHASHI Aya, Associate Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
HARUTA Shin, Associate Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
KATO Hidetoshi, Assistant Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
OKABE Yutaka, Guest Professor	Graduate School of Science and Engineering, Dept. of Physics
Sudhir Kumar, Director	Institute for Genomics and Evolutionary Medicine, Temple University
Frank Eisenhaber, Director	Bioinformatics Institute, A*STAR Singapore
Hwee Kuan Lee, Head of Division	Bioinformatics Institute, A*STAR Singapore

Research Center for Artificial Photosynthesis

INOUE Haruo, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
MASUDA Hideki, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
TACHIBANA Hiroshi, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
TAKAGI Shinsuke, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
SHIMADA Tetsuya, Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
NABETANI Yu, Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry

Research Center for Gold Chemistry

HARUTA Masatake, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
KUBO Yuji, Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
TAKEI Takashi, Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
TAKETOSHI Ayako, Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
ISHIDA Tamao, Project Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
MURAYAMA Toru, Project Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
NISHIGAKI Junichi, Project Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
FUJITA Takashi, Project Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
YOSHIDA Takuya, Project Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Applied Chemistry
FUJITANI Tadahiro, Principal Research Manager	National Institute of Advanced Industrial Science and Technology, Interdisciplinary Research Center for Catalytic Chemistry
AKITA Tomoki, Group Leader	National Institute of Advanced Industrial Science and Technology, Material Science Research Group
MONKAWA Akira, Chief Researcher	Tokyo Metropolitan Industrial Technology Research Institute
Jorge Boczkowski, Director & Professor	Institut national de la santé et de la recherche médicale, Paris, France
Sophie Lanone, Researcher	Institut national de la santé et de la recherche médicale, Paris, France

Quick Facts

Founded in 1949

The international co-authorship of research papers

10.1 % of ratios of

Ranked the 7 th in Japanese Universities and received

(Times

383 International Students from 25

Research Center for Language, Brain and Genetics

HAGIWARA Hiroko, Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
HONMA Takeru, Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
HARADA Naomi, Associate Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
HOMAE Fumitaka, Associate Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
HASHIMOTO Ryu-ichiro, Associate Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
FUCHINO Yutaka, Assistant Professor	Graduate School of Humanities, Dept. of Human Sciences, Language Sciences
SHIMOKAWA Akio, Professor	Graduate School of Humanities, Dept. of Human Sciences, Psychology and Clinical Psychology
ISHIHARA Masami, Associate Professor	Graduate School of Humanities, Dept. of Human Sciences, Psychology and Clinical Psychology
SEKIHARA Kensuke, Professor	Graduate School of System Design, Dept. of Intelligent Mechanical Systems
KIKUCHI Yoshiaki, Professor	Graduate School of Human Health Sciences, Dept. of Frontier Health Sciences
IMANAKA Kuniyasu, Professor	Graduate School of Human Health Sciences, Dept. of Health Promotion Sciences
AIGAKI Toshiro, Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
SAKAI Takaomi, Associate Professor	Graduate School of Science and Engineering, Dept. of Biological Sciences
YUHARA Ichiro, Associate Professor	University Education Center, Tokyo Metropolitan University
YOSHIKAWA Takeo, Senior Team Leader	RIKEN Brain Science Institute, Molecular Psychiatry
NISHIDA Atsushi	Mental Health Promotion Project, Tokyo Metropolitan Institute of Medical Science

Research Center for Water System Engineering

KOIZUMI Akira, Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
INAKAZU Toyono, Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
ARAI Yasuhiro, Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
YAMAZAKI Kimiko, Assistant Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
KUNIZANE Takaharu, Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
UJI Kimitaka, Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
KAWAMURA Akira, Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
YOKOYAMA Katsuhide, Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Civil and Environmental Engineering
KOO Jayong, Professor	University of Seoul, Dept. of Environmental Engineering
SATO Chikafusa, Part-time Lecturer	Former Director of Water Quality Management Center, Bureau of Waterworks, Tokyo Met. Gov./Graduate School of Urban Environmental Sciences

Research Center for Community Centric Systems

YAMAGUCHI Toru, Professor	Graduate School of System Design, Dept. Information and Communication Systems
KUBOTA Naoyuki, Professor	Graduate School of System Design, Dept. of Intelligent Mechanical Systems
ICHIKO Taro, Associate Professor	Graduate School of Urban Environmental Sciences, Dept. of Urban Science
NITTA Osamu, Professor	Graduate School of Human Health Sciences, Dept. of Physical Therapy
TAKAMA Yasufumi, Professor	Graduate School of System Design, Dept. Information and Communication Systems
HASHIMOTO Mime, Associate Professor	Graduate School of Human Health Sciences, Dept. of Occupational Therapy
WADA Kazuyoshi, Associate Professor	Graduate School of System Design, Dept. of Intelligent Mechanical Systems
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KIYA Hitoshi, Professor	Graduate School of System Design, Dept. Information and Communication Systems
SHIOTA Sayaka, Assistant Professor	Graduate School of System Design, Dept. Information and Communication Systems
SHIMOKAWARA Eri, Assistant Professor	Graduate School of System Design, Dept. Information and Communication Systems
Gikin Ka, Assistant Professor	Graduate School of System Design, Dept. Information and Communication Systems
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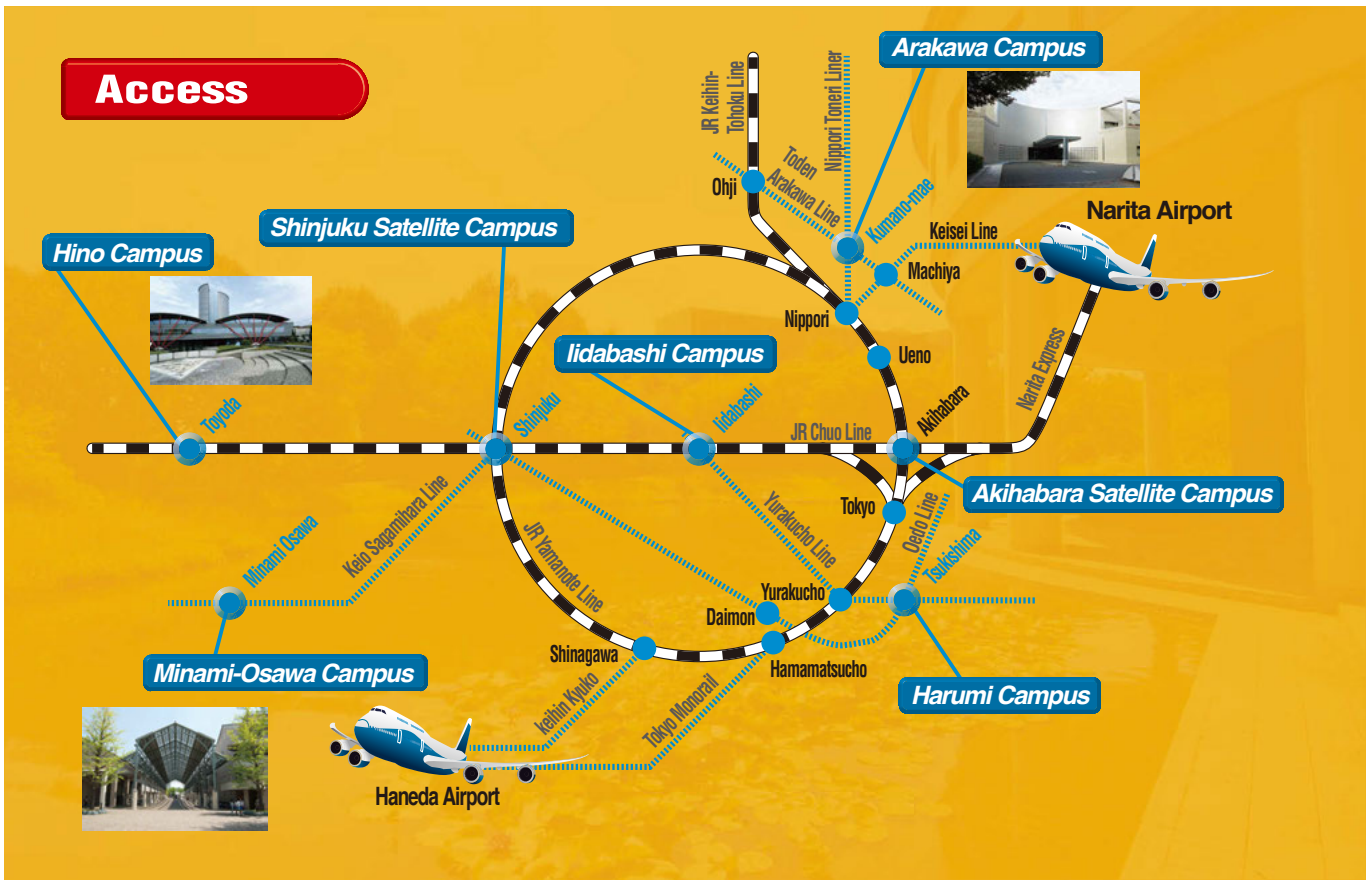
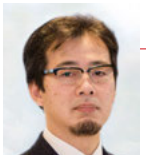
Lieu-Hen Chen, Associate Professor (Taiwan National Chi Nan University)	Graduate School of System Design, Dept. Information and Communication Systems
Chen, Yu-Sheng, Visiting Researcher	Graduate School of System Design, Dept. Information and Communication Systems
Honghai Liu, Professor	University of Portsmouth, School of Computing
Wangli He, Associate Professor	East China of science and Technology University, Dept. of Automation
Kevin Wong, Associate Professor	Murdoch University, School of Engineering and Information Technology



Introduction—University Research Administrator, Intellectual property manager

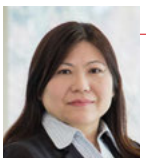


Masataka Sakurai
(Head of Research Administration Office & Liaison Office)

Place of birth: Nagoya. Graduated from the Faculty of Economics, Hitotsubashi University. **Career:** Worked for 20 years in investment and loans, management consulting, and joint industry/academic projects. At current position since 2011. Also an outside director of venture businesses; instructor at the Japan Patent Office; former external board member of METI. **Interests:** Watching NFL, heavy metal.

Hiroshi Kunimasa
(Chief URA, International support group)

Place of birth: Kumamoto. Graduated from the Faculty of Economics, Kobe University. **Career:** Worked for 21 years in investment and loans and securities at domestic and foreign banks. At current position since 2010. Also a securities analyst. **Area of expertise:** Analysis of financial market and industry trends. **Interests:** Golf; recreational driving.



Kiriko Abe (Chief URA, Strategy public relations group)

Place of birth: Fukuoka. Graduated from the Faculty of Engineering, Okayama University. **Career:** Followed eight-year stint at patent firm, engaged in industry/academic collaboration projects at the University of Yamanashi, Keio University, and Hamamatsu University School of Medicine. At current position since 2013. **Credentials:** Master of Engineering, 1st grade Certified Specialist of Intellectual Property Management (patent) MBA. **Interests:** Visiting shrines and temples; aquariums; dinosaurs

Toshihiko Nakanishi (Chief URA, Social cooperation group)

Place of birth: Hokkaido. Graduated from the Faculty of Economics, Hokkaido University. **Career:** Became independent consultant after working in the sales department at a sanitary ware manufacturer. At current position since 2013. **Credentials:** Registered Smaller Enterprise Consultant. **Areas of expertise:** Strategy, finance, general affairs and human resource consulting. **Interests:** Travel; cycle racing.

Tomohiro Suzuki (Chief URA, Social cooperation group)

Place of birth: Tokyo. Graduated from the School of Commerce, Senshu University. **Career:** Formerly worked at Tama Shinkin Bank, mainly as corporate solutions advisor. Active since 2014 as dispatched coordinator for industry/academic/government collaborative projects. **Credentials:** 2nd grade Certified Skilled Worker of Financial Planning, professional cooking license. **Interests:** Angling, recreational driving.

Toru Shibata (Chief URA, Research support group)

Place of birth: Okayama. Graduated from the Faculty of Engineering, Yamaguchi University. **Career:** Worked at NEC and a consulting firm before founding his own company. At current position since 2011. Also president of venture company based on TMU and lecturer in Rikkyo University's MBA program and active in many other posts. **Interests:** playing baseball in mornings; dog rescue volunteer.

Naoya KUZAWA (Chief URA, Research support group)

Place of birth: Aichi. Graduated from the Nagoya Institute of Technology, Faculty of Engineering. **Career:** 20 years in research and development and intellectual property work for a major chemical manufacturer. At current position since 2015. **Areas of expertise:** 1st grade Certified Specialist of Intellectual Property Management (patent). **Interests:** Ski, street performance.

Satoru NIIMURA (Integration manager of intellectual properties)

Place of birth: Tokyo. Graduated from Chuo University, Faculty of Science and Engineering. Qualified patent attorney. **Career:** Worked 33 years in intellectual property for a precision equipment manufacturer. Engaged. At current position since 2014. **Areas of expertise:** Participated in diplomatic conferences on patent law treaties as representative of the Japan Intellectual Property Association and served as executive secretary for the Association for the Study of International & Foreign Patent & Trademark Laws & Practice, etc. **Interests:** Listening to music.

Hirokazu Fujimoto (Intellectual property manager)

Place of birth: Saitama. Graduated from the Faculty of Science, Tokyo University of Education (currently Tsukuba University). Thereafter studied at the university's graduate school, earning a PhD in Science. **Career:** After working at the Mitsubishi Kagaku Institute of Life Sciences as researcher, worked for seven years in industry/academic joint efforts as patent advisor at Keio University. At current position since 2011. **Interests:** Tropical fish; gardening

Yuichiro Matsuyama (Adviser patent attorney)

Place of birth: Miyazaki. Graduated from the Faculty of Engineering, Kanagawa University. **Career:** Worked as chemical engineer before moving on to work for 20 years at patent firm; has served as advisor for Tokyo Metropolitan University since 2011. Holds concurrent positions as part-time lecturer at the Tokyo Metropolitan University and Kanagawa University. **Credentials:** Chartered patent agent, Master of Technology Management. **Interests:** Walking, assembling custom PCs.

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