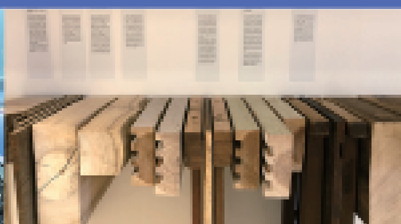
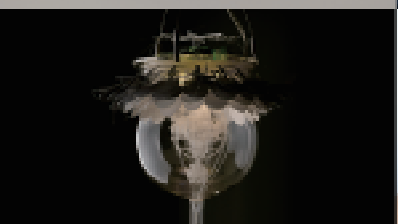
UTokyo-IIS Bulletin

Vol.10 September 2022

Institute of Industrial Science,
The University of Tokyo








東京大学生産技術研究所
Institute of Industrial Science, The University of Tokyo

Professor
Nobuhiro Yoshikawa

Hydrogen: energy vital for net zero

Professor Yoshikawa uses simulations and machine learning to develop light, low-cost fuel tanks for hydrogen-powered vehicles.

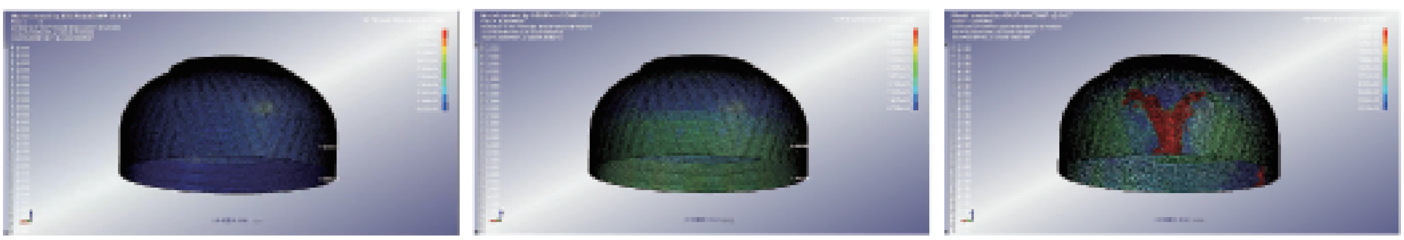
Japan has been in the forefront of research and development concerning the use of hydrogen energy for vehicles since the government committed itself about 20 years ago to creating a "hydrogen society." Professor Nobuhiro Yoshikawa of the Institute of Industrial Science, the University of Tokyo (UTokyo-IIS), is conducting research aimed at developing hydrogen-powered fuel cell vehicles (FCVs), which are seen as ideal eco-friendly cars because they do not emit carbon dioxide. His approach is to help develop light, low-cost fuel tanks that can hold high-pressure hydrogen. Such fuel tanks are a key component in fuel cell cars, the widespread adoption of which is essential if Japan wants to attain carbon neutrality by 2050.

Professor Nobuhiro Yoshikawa began conducting research aimed at developing fuel tanks to hold compressed natural gas around 1990 when he was a UTokyo research associate. It wasn't his idea — the project was suggested by one of his superiors. The opportunity to switch his research target to FCV fuel tanks came unexpectedly in the early 2010s, when the Japanese government decided to develop hydrogen energy in an effort to boost the country's stagnant economy.

"Toyota Motor decided to develop an FCV that required a high-pressure hydrogen fuel tank, but at that time, there was almost nobody but me who was conducting research on fuel tanks in Japan," Yoshikawa says. "So, the carmaker asked me to help with its development. When I began conducting researching into natural gas fuel tanks, I never imagined that my research would become useful in this way."

North America and Europe, however, are ahead of Japan when it comes to making fuel tanks because of their long and deep experience in making them for vehicles that run on natural gas, according to Yoshikawa.

Yoshikawa's lab claims to be the only entity that is capable of accurately predicting how and when a hydrogen fuel tank will break by conducting thorough simulations. His lab honed its precision in making mathematical models for this purpose thanks to its involvement in a project to use the K computer (once the world's fastest computer) in research that can be utilized in manufacturing.



Simulation of the strength of a bundle of carbon fibers wrapped around a hydrogen tank
As the pressure inside the tank rises, distortion occurs in the carbon fiber bundle (indicated in green). Complex distortion occurs in parts where the bundles overlap (indicated in red), causing the bundle to snap from the inner part.

Involved in NEDO project to spark innovation

FCVs have many advantages as eco-friendly cars. For example, an FCV hydrogen fuel tank can be refilled in a matter of a few minutes, whereas it takes around 30 minutes to recharge a Battery Electric Vehicle (EV hereinafter) Also, the fuel tank is suitable for large vehicles, such as long-haul trucks, because it is much lighter than the battery for large vehicles.

Despite these advantages, there has been only limited penetration of FCVs in Japan's auto market. As the end of March 2020, the number of FCVs owned by individuals and entities stood at just 5,170, compared with 123,706 for EVs, according to the Next Generation Vehicle Promotion Center. Its data also shows that Japan had 161 hydrogen stations as of March 2022, while there were 21,198 EV recharging stations.

Along with the high price of hydrogen, hindering the spread of FCVs is the use of carbon fiber reinforced plastics (CFRP) in making hydrogen fuel tanks that can withstand a pressure of 70MPa — about 700 times standard atmospheric pressure. The large amount of CFRP required makes FCVs heavy and expensive.

Yoshikawa is now involved in a project sponsored by the New Energy and Industrial Technology Development Organization (NEDO) to make an innovative hydrogen storage system for fuel cell vehicles that reduces the use of CFRP.

His lab is trying to develop a high-pressure hydrogen fuel tank that consists of a resin container with a cylindrical body with two dome-like ends (one end has a metal boss and the other a metal valve). Strips of CFRP are wrapped around the tank to boost its strength, as well as glass fiber reinforced plastics (GFRP) to prevent scratches. Both the strong and weak parts of the tank are evenly bound with CFRP in the reinforcement process, meaning the strong parts are excessively reinforced to ensure the weak parts are sufficiently durable.

"The lighter the vehicle, the better the gas mileage," Yoshikawa says. "We are trying to minimize the overall use of CFRP as much as possible by using simulations to accurately predict how and when the weakest parts of a tank break." The idea is to drastically change the way to ensure the safety of a fuel tank by establishing a system to detect signs of imminent failure. That would allow the use of the weakest fuel tank possible, which will be monitored around the clock by a sensor that is connected to the internet and replaced as necessary.

Evaluation of hydrogen tanks' strength
It involves repeated analysis through simulations, designing tanks, and experiments in which actual tanks are ruptured.

Photo by Gottingham

Mesoscale analysis to predict tank strength

Yoshikawa's lab is improving the accuracy of its analysis through simulations of how fuel tanks break at the mesoscale level.

The tank is bound by a bundle of several thousand carbon fibers that are consolidated with flexible and soft resin and hardened by high heat. It is therefore necessary to understand how the resin will slowly break before the carbon fibers snap. Yoshikawa says this is a complicated process that is difficult to predict.

His lab is developing a simulation system called FrontCOMP that can make an accurate evaluation of the strength of CFRP and the ability of the tank to withstand pressure before bursting, based on a mesoscale model that combines strength models of both carbon fibers and resin.

Yoshikawa says the simulator can evaluate the impact on the strength of a fuel tank of common faults that emerge while it is being made, such as gaps created on its surface when binding it with CFRP or heating. That's another step toward designing and manufacturing an optimal fuel tank.

Applying machine learning with the help of his former student

Yoshikawa uses machine learning in his research in collaboration with SUPWAT Inc., a startup launched by one of his former students at UTokyo's Graduate School of Engineering. "We use machine learning to pinpoint how much and where we can reduce CFRP," he says, "because there are a vast number of patterns in wrapping CFRP around a resin container, for example — a fact that is difficult for humans to handle.

"In the future, we'd like to make the software, including the simulator and the machine learning system, available with fees to any manufacturer that wishes to use it for making a tank in order to advance our research into hydrogen fuel tanks," Yoshikawa says. SUPWAT is also participating in the NEDO project.

Regarding his future aspirations, Yoshikawa said he wants to survive live at least 28 more years to see whether Japan has achieved carbon neutrality in 2050. "If FCVs have spread by then, we will have much more clean air and less noise generated by vehicles," he says.

Further information Yoshikawa Laboratory http://www.young.iis.u-tokyo.ac.jp/

Making electric vehicles green energy consumers

Project Associate Professor Baba and Project Research Associate Imanaka are devising methods to boost EV usage as a key adjuster of Japan's electricity demand.

To help prevent the worst consequences of climate change, Japan and more than 100 other nations have pledged to achieve carbon neutrality, or net-zero carbon dioxide emissions. However, Japan lags far behind many European nations in the wide adoption of Battery Electric Vehicles (EV hereinafter), which have been touted as eco-friendly because they do not emit greenhouse gases. To rectify this situation, Project Associate Professor Hiroyuki Baba and Project Research Associate Masaki Imanaka, both of UTokyo-IIS, are developing IoT-based technologies to charge electric vehicles in a more eco-friendly manner by adjusting demand for electricity generated from renewable energy sources.

Project Research Associate
Masaki Imanaka

Project Associate Professor Hiroyuki Baba is harnessing his decades of experience in electronics in the private sector as he conducts research on a demand-side power system using the Internet of Things (IoT), in which EVs play a leading role in adjusting electricity demand by storing power in their batteries.

Baba worked for Tokyo Electric Power Company, one of Japan's major utilities, for 30 years. As a 38-year-old executive, Baba was dispatched to a joint venture the utility established with the task of developing and providing a wireless, high-speed Internet communication system. Baba joined IIS seven years ago and his input — together with other researchers — has culminated in the development of IoT-HUB, an innovative system that is essential for controlling power demand.

"EV and other devices' batteries can be charged when there is surplus electricity supply, such as in the daytime during public holidays or in spring and autumn, and taken off the charger when the supply is tight, such as on wintry days," Baba said at IIS' Comfort Management (COMMA) House, an experimental smart house where IoT-HUB was developed. "This requires electricity retailers to remotely control power demand, via the Internet, of EVs and various devices with different communication protocols. We want to use IoT-Hub for this task."

Failure to maintain balance in the electricity grid could result in blackouts. The increase in renewable energy production, which can fluctuate greatly depending on the weather, has made maintaining this balance increasingly difficult.

Japan is walking a tightrope when it comes to balance in the power grid. Recently, electricity users were asked several times to save energy to avoid a blackout. On the other hand, feeding various renewable energy sources, such as solar and wind power, into the grid has frequently been restricted for the same reason.

Maintaining the balance will be even more crucial in the future. Japan's government aims to increase the proportion of renewable energy in the total power output to 36%-38% by 2030 from 22% as of March 2022 (data from the International Energy Agency). This is where EVs come in to assist thermal power for achieving a balance in power supply and demand, according to Baba and Project Research Associate Masaki Imanaka.

COMMA House

EV charging test bed

EV charging test bed on campus

Baba and Imanaka are using a test bed for charging EV batteries, set up on UTokyo's Komaba Research Campus, to help solve problems associated with charging EVs that hamper wider use of these vehicles in Japan.

In 2021, EVs and plug-in hybrids accounted for about 1% of Japan's new car sales, compared with 15% for China and the entire European Union, according to IEA statistics. European nations Norway (86%), Iceland (72%) and Sweden (43%) boast much higher proportions of eco-friendly cars among new vehicle sales.

The research team has built up the test bed to study issues such as simplifying a user authentication system for recharging EVs that many say is cumbersome; encouraging drivers to charge batteries during the daytime when solar power can be easily generated; and changing the billing system to allow the cost of charging at a destination or EV station to be included in home electricity bills.

"We also need more charging stations," Imanaka said. Only 21,198 EV charging stations were operating across Japan as of March 2022, according to the Next Generation Vehicle Promotion Center.

IoT-HUB: A handy tool to adjust power demand

The use of IoT-HUB is key. The interconnection infrastructure system can quickly connect EVs and apps that control the charging of their batteries. Based on electricity balance forecasts provided by power companies and information on stored electricity in batteries, apps boost EV charging power when a supply surplus is forecast and slow or stop charging when a grid power shortage is projected.

The cloud-based system is capable of connecting devices made by different manufacturers and with different communication protocols, by using a "driver," similar to the software that allows a computer to interact with a printer manufactured by a different maker. This system is capable of connecting to electric appliances including EV chargers, heat-pump boilers, air conditioners and storage batteries, and controlling their power usage. The system has already been put to practical use in some areas, Baba said.

EVs should be powered by green energy to make them truly eco-friendly. According to IEA data, renewable energy accounted for 22% of Japan's electricity in 2021, about the same as India and the United States (both 21%), but far less than Sweden, Brazil and Canada (80%, 75% and 74%, respectively), which generate 50% or more through hydropower. "If Japan's proportion of renewable energy reaches 40% to 60%, EVs in Japan could be powered mainly by renewable power," Imanaka said. Citing one study, Baba said increasing Japan's total energy output by 10% would be enough to power all passenger EVs.

Ultimately, Baba said, EVs must be more convenient and attractive than gasoline-powered cars to gain wider acceptance. "The key is autonomous driving," he said. "When EVs can be driven autonomously, it could open the door for various driving apps developed by third-party companies — like the Internet eventually led to the development of a myriad of smartphone apps. When that happens, EVs will be totally different vehicles from gasoline cars."

Baba recently organized a study group among experts from academia and the business sector dedicated to commercializing a communication infrastructure solely for a demand-side power system based on IoT-HUB. "I have been fortunate to develop a superb network of people in academia and the private sector, and many of them are joining my research projects," Baba said.

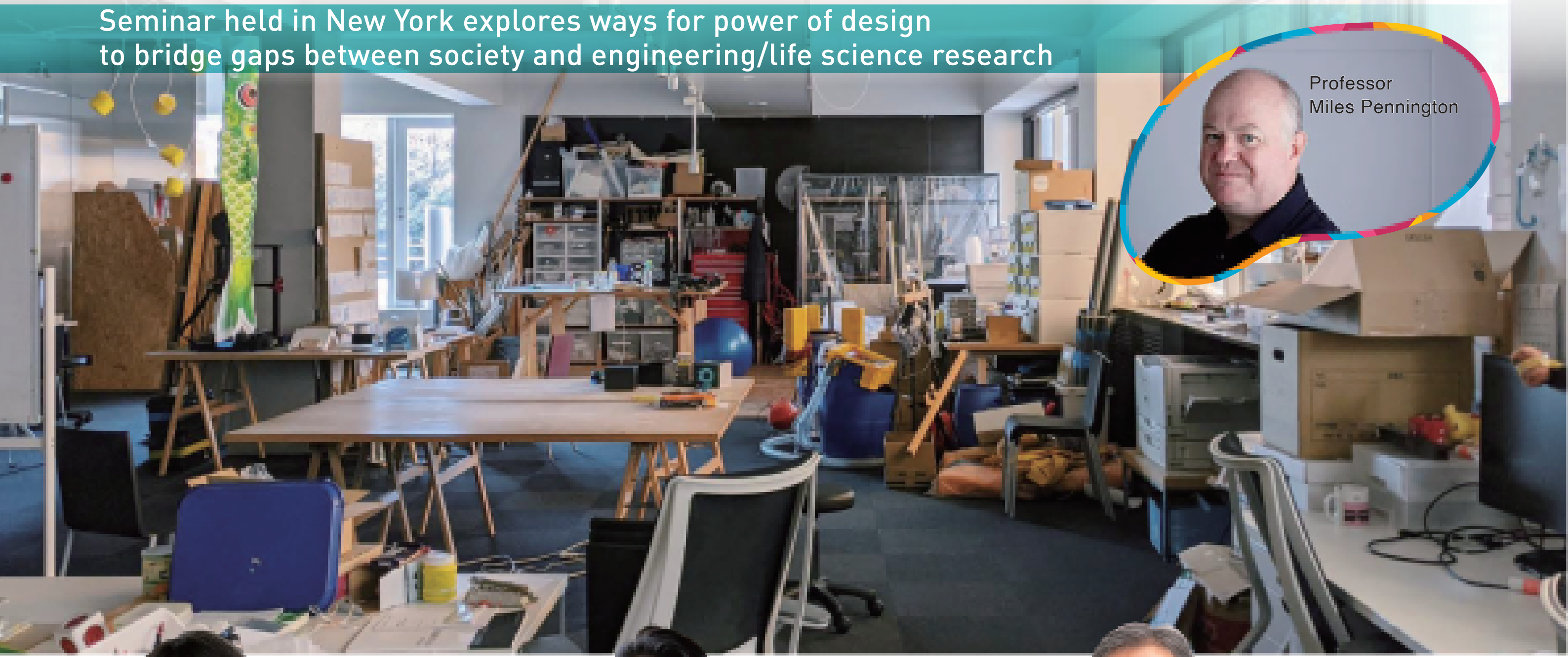
Further information

Baba Laboratory
https://www.babahiroyukilab.iis.u-tokyo.ac.jp/

COMMA House
http://www.commahouse.iis.u-tokyo.ac.jp/english/

DELIVERING THE VISION

Seminar held in New York explores ways for power of design to bridge gaps between society and engineering/life science research



Professor
Miles Pennington

Associate Professor
Yoshiho Ikeuchi

Associate Professor
Yoshiyuki Kawazoe

UTokyo President and
former IIS Director General
Teruo Fujii

UTokyo-IIS held a seminar titled "Delivering the Vision — Closing the gap between academic research and society" on June 13, 2022, at the university's New York Office to belatedly showcase the facility that underwent major renovations in 2020. The seminar focused on the institute's research activities at the boundary between life science and engineering. It demonstrated IIS efforts to facilitate further research and spark innovation through interdisciplinary dialogue and collaboration among researchers, engineers, designers and those outside the university who are willing to support such research. Participants in this thought-provoking event were Professor Miles Pennington (design-led innovation); Associate Professor Yoshiho Ikeuchi (biomolecular and cellular engineering); and Associate Professor Yoshiyuki Kawazoe (design of architecture), all from IIS. UTokyo President and former IIS Director General Teruo Fujii joined the session online from Japan as a keynote speaker.

In 2014, Associate Professor Yoshiho Ikeuchi began studying the mechanisms of neural development and related disorders at IIS. Interactions several years later with IIS' Design-Led X Platform (DLX Design Lab) made a great impact on Ikeuchi's mindset toward research.

"It has been really amazing," Ikeuchi said at the seminar, referring to DLX Design Lab, which was established in 2017 with the aim of fusing design and science to deliver research outputs to the industrial sector and society at large. DLX Design Lab, Ikeuchi said, helped him envision how his scientific research could help society in the future with "intellectual stimulation, excitement and imagination."

His laboratory is trying to understand how brains form and function by making neuronal circuits outside the body with the help of a micro device developed jointly with UTokyo President Teruo Fujii when he was IIS director general. Neural circuits are made in the device by connecting brain-like tissues generated from human iPS (induced pluripotent stem) cells to mimic how neurons — a building block of the brain — function.

AURA-Bio-Intelligent Machines (microlab)

During the joint project between Ikeuchi lab and DLX Design Lab, they envisioned a health monitoring device "Aura" which can monitor a person's biochemical signals and detect health issues using computational power of the neural circuits grown outside of our body. "Of course, it is a future product concept...but it gives us ways to think about what is needed to make it," Ikeuchi said. "That's really an exciting part of the interaction with DLX Design Lab."

Professor Miles Pennington, who oversees DLX Design Lab, said the lab had handled about 20 projects, including Aura. "Our mission is to try and create value through design," he told the seminar, adding that the value comes in three different ways and can be obtained only through partnership between designers and researchers.

"There is a value in helping researchers to create product and service ideas that could be commercialized; there is a value in simply bringing the general public closer to the work of the university, either through kind of citizen science-type projects, or by disseminating knowledge from research to the general public more clearly," he said. "The third we call visionary, which is about working with the researchers to try and help them see the future of their research clearly, by prototyping and visualizing ideas that come from their research."

IIS has more than 120 labs and more than 1,000 researchers from Japan and elsewhere, working on almost all engineering disciplines from the quantum level to the space domain. IIS is a prime institute to conduct what Pennington called "treasure-hunting," or searching for "hidden gem" research to develop into ideas for commercialization.


the Ocean Monitoring Network Initiative (OMNI)

Associate Professor Yoshiyuki Kawazoe introduced interesting research on empirical architecture, or the marriage between architecture and life science. "We are spending more than 90 percent of a day indoors... so this kind of physical environment has a very big impact on our body and mental situation," Kawazoe said, explaining why he launched the project.

Kawazoe analyzed how brain electrical signals react when people see architectural elements, with various texture, colors and sizes. For example, he found greenery relaxes people by prompting their brains to emit theta waves — signs of relaxation that can spark creativity.

"We would like to add these physiological aspects of design, which we can call human-centered design," Kawazoe said. "So not only the engineering, but also life science will change the process of design."

In his keynote speech, Fujii emphasized the importance of finding practical ways to close the gap between academic research and society through dialogue and referred to one of DLX Design Lab's projects, the Ocean Monitoring Network Initiative (OMNI), as an example. This project employs a flexible-use, low-cost and easily deployable ocean sensor system to gather detailed and diverse data from the sea.

Fujii said anybody in the world can participate in the project. "We hold a kind of workshop to think about how to use this device which can be assembled easily and used by high school or university students or somebody who enjoys ocean sports," he said. OMNI's technology solutions and data can be shared with any member of society.

Fujii also discussed the university's roles in green transformation to safeguard the global commons, such as oceans, the atmosphere, forests and land. For example, the university's Center for Global Commons in May 2022 unveiled the latest report of the Global Commons Stewardship Index which measures each country's contribution to saving the global commons, together with the U.N. Sustainable Development Solutions Network and Yale University. This index aims to promote behavioral change in society to save Earth from an environmental calamity. Fujii also mentioned UTokyo's input to the Intergovernmental Panel on Climate Change's Sixth Assessment Report, through global atmospheric simulations using Japan's supercomputer Fugaku.

These endeavors all resonate with UTokyo Compass, the university's guiding principles that Fujii introduced in autumn 2021. During the seminar, Fujii stressed the importance of "dialogue," "diversity and inclusion" and becoming "a university that anybody would want to join."

During an open discussion that followed the presentations, the participants talked about how IIS is "an inspiring, catalytic place," as Pennington put it. They also spoke about the "Shelf of Wisdom," a unique shelf at the New York Office that was designed by Kawazoe, who led the renovation work, and decorated with pieces of used timber from across Japan. The discussion was moderated by Alicia Tam Wei, a design strategist who teaches at Parsons School of Design and Rhode Island School of Design.

The seminar, which had been postponed several times due to the COVID-19 pandemic, was attended by students and businesspeople in the office as well as online viewers. UTokyo's New York Office was established in 2015 to facilitate research, academic and social collaboration activities in the United States. It was renovated in 2020 to create an open space for seminars, workshops and events as a communication hub to bolster the university's presence in North America.


Shelf of Wisdom


Lecturer
Parsons School of Design,
The New School
Alicia Tam Wei

Further information

Ikeuchi Laboratory
http://www.bmce.iis.u-tokyo.ac.jp/

Kawazoe Laboratory
http://www.kwz.iis.u-tokyo.ac.jp/

Design-Led X Platform
https://www.designlab.ac/

UTokyo New York Office
https://utokyony.adm.u-tokyo.ac.jp/

New antibody detection method for coronavirus that does not require a blood sample

Researchers report a new, minimally invasive, antibody-based detection method for SARS-CoV-2 that could lead to the blood sample-free detection of many diseases.

Professor Beomjoon Kim

Doctor's Degree Program 3rd **Leilei Bao of Kim Lab**

Despite significant and stunning advances in vaccine technology, the COVID-19 global pandemic is not over. A key challenge in limiting the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is identifying infected individuals. Now, investigators from Japan have developed a new antibody-based method for the rapid and reliable detection of SARS-CoV-2 that does not require a blood sample.

The ineffective identification of SARS-CoV-2-infected individuals has severely limited the global response to the COVID-19 pandemic, and the high rate of asymptomatic infections (16%–38%) has exacerbated this situation. The predominant detection method to date collects samples by swabbing the nose and throat. However, the application of this method is limited by its long detection time (4–6 hours), high cost, and requirement for specialized equipment and medical personnel, particularly in resource-limited countries.

An alternative and complementary method for the confirmation of COVID-19 infection involves the detection of SARS-CoV-2-specific antibodies. Testing strips based on gold nanoparticles are currently in widespread use for point-of-care testing in many countries. They produce sensitive and reliable results within 10–20 minutes, but they require blood samples collected via a finger prick using a lancing device. This is painful and increases the risk of infection or cross-contamination, and the used kit components present a potential biohazard risk.

Lead author Leilei Bao from UTokyo-IIS, explains: "To develop a minimally invasive detection assay that would avoid these drawbacks, we explored the idea of sampling and testing the interstitial fluid (ISF), which is located in the epidermis and dermis layers of human skin. Although the antibody levels in the ISF are approximately15%–25% of those in blood, it was still feasible that anti-SARS-CoV-2 IgM/IgG antibodies could be detected and that ISF could act as a direct substitute for blood sampling."

After demonstrating that ISF could be suitable for antibody detection, the researchers developed an innovative approach to both sample and test the ISF. "First, we developed biodegradable porous microneedles made of polylactic acid that draws up the ISF from human skin," explains Beomjoon Kim, senior author. "Then, we constructed a paper-based immunoassay biosensor for the detection of SARS-CoV-2-specific antibodies." By integrating these two elements, the researchers created a compact patch capable of on-site detection of the antibodies within 3 minutes (result from *in vitro* tests).

This novel detection device has great potential for the rapid screening of COVID-19 and many other infectious diseases that is safe and acceptable to patients. It holds promise for use in many countries regardless of their wealth, which is a key aim for the global management of infectious disease.

Reference

Leilei Bao, Jongho Park, Boyu Qin and Beomjoon Kim*
"Anti-SARS-CoV-2 IgM/IgG antibodies detection using a patch sensor containing porous microneedles and a paper-based immunoassay"
Scientific Reports **(2022), DOI: https://doi.org/10.1038/s41598-022-14725-6**

Wildlife–human conflicts could shift with climate change

Researchers from UTokyo-IIS, find that the risk of human–elephant conflict in Thailand is likely to shift with climate change.

Professor Wataru Takeuchi

Dr. Nuntikorn Kitratporn
[PhD at IIS in 2020, Geo-informatic Scientist, Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand]

As natural areas become increasingly fragmented, the potential for humans and wildlife to interact is growing. Now, researchers from Japan have found that climate change is altering the risk of such interactions.

In a recent study published in Science of the Total Environment, a team led by Professor Wataru Takeuchi of UTokyo-IIS examined how the risk of human–elephant conflict could change over time. When humans encroach on natural landscapes, the chances of interactions with wildlife increase. Conflicts can arise when wildlife damages livestock or crops, or when human activities damage animal habitat. For example, forest edges are particularly attractive areas for elephants on the hunt for food, which can bring them into contact with mature crops, or with farmers.

"In Thailand, half of the country's population live in rural areas and rely on agriculture," says lead author Nuntikorn Kitratporn. "Thailand also has about three to four thousand wild elephants and deforestation and the growth of commercial agriculture have pushed elephants into increasingly fragmented patches of habitat, increasing the chance of interactions between humans and elephants."

Climate change is bringing additional complexity to these interactions, as changing environmental conditions lead to changes in the behavior and distribution of elephants. In rural areas where people depend on agriculture to survive, human–elephant conflict may well intensify in the future. To assess the risk of this, the researchers used a risk framework that incorporated different possible scenarios. They used this framework to examine the recent spatial distribution of human–elephant conflict (2000–2019) in Thailand and how it may look in the near future (2024–2044). Different projections of future climate and socioeconomic conditions were incorporated into the framework and the effects on land use were examined.

"We found a spatial shift in risk toward northern areas and higher latitudes," says Nuntikorn Kitratporn. "In other areas, habitat is likely to become less suitable over time, which could first increase and gradually decrease the risk of interactions."

Understanding how human–wildlife interactions may change in the future is vital for long-term planning. The results from this study could be used to develop planning strategies in affected communities and raise awareness of ways in which humans and wildlife can coexist.

Reference

Nuntikorn Kitratporn, Wataru Takeuchi
"Human-elephant conflict risk assessment under coupled climatic and anthropogenic changes in Thailand"
Science of the Total Environment (2022), DOI: 10.1016/j.scitotenv.2022.155174

Dissolving the Problem: Organic Vapor Induces Dissolution of Molecular Salts

A research team led by Kazuyuki Ishii has found that organic vapor can dissolve molecular salts in a phenomenon known as organic deliquescence. Similar to how water vapor can induce deliquescence of compounds like calcium chloride, this phenomenon will be useful for developing methods for capturing harmful volatile organic compounds (VOCs). There is an urgent need to remove them from indoor environments, particularly industrial facilities, where concentrations are highest.

RSC Advances (2022), DOI: 10.1039/D2RA03390A

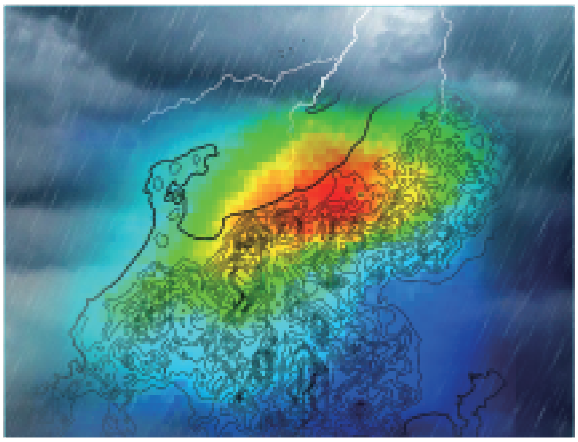
Further information https://www.iis.u-tokyo.ac.jp/en/news/3905/

Building Up New Data-Storage Memory

A research team led by Masaharu Kobayashi build a proof-of-concept data-storage memory cell based on field-effect transistors using a combination of ferroelectric and antiferroelectric materials with oxide semiconductor channel. By forming the memory units vertically, a larger arial density can be achieved. This work may lead to more practical data storage in mobile devices.

2022 IEEE Silicon Nanoelectronics Workshop

Further information https://www.iis.u-tokyo.ac.jp/en/news/3888/

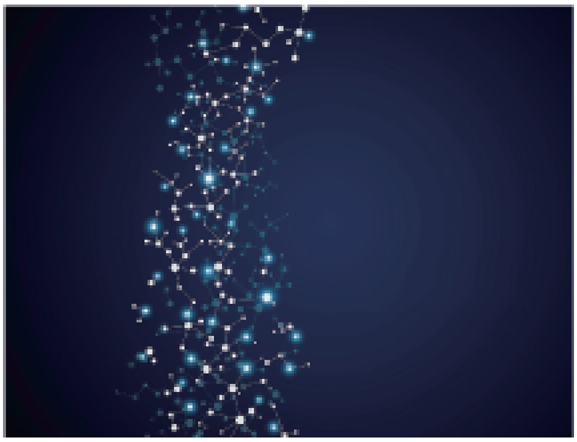


Machine learning produces more accurate rainfall predictions

A research team led by Takao Yoshikane developed a method for producing more accurate estimates of local precipitation. A bias correction method using machine learning, which recognizes the complex relationships influencing local precipitation, was used to estimate hourly precipitation frequencies. The method could accurately predict spatial precipitation systems at scales of 2500–40000 km^2, which determined local hourly precipitation frequencies. The improved estimates can be used for more precise water management.

PLOS Water (2022), DOI: 10.1371/journal.pwat.0000016

Further information https://www.iis.u-tokyo.ac.jp/en/news/3851/



Feel the Attraction of Zwitterionic Janus Particles

A research team led by Kyohei Takae created a more accurate computer simulation of double-faced nanoparticles that form self-assembled structures based on electrostatic attraction. By including temporary charge fluctuations, compact clusters are shown to be a possible outcome, which may lead to new smart nanomaterials.

Physical Review Letters (2022), DOI: 10.1103/PhysRevLett.128.158001

Further information https://www.iis.u-tokyo.ac.jp/en/news/3823/

Professor Toru H. Okabe, Director General

Message from the Director General / Scope

The Covid-19 pandemic has transformed our lives, making us realize the limits of science and technology against formidable viruses. At the same time, through remote work and online lectures, we have become more aware of the importance and the future potential of digital transformation (DX). Many issues cannot be solved by technology alone. However, engineering is expected to play an increasingly important role in meeting the challenges of modern society, which has become ever more complicated and diversified.

The Institute of Industrial Science (IIS) at the University of Tokyo is the largest university-affiliated research institute in Japan. With a commitment to pursuing academic truth, the UTokyo-IIS carries out a wide range of educational and research activities, such as cross-disciplinary research that transcends academic boundaries — which is a traditional feature of the UTokyo-IIS — as well as practical industry–academic collaboration, international collaboration, and hands-on research aimed at social implementation.
In 2019, we celebrated our 70th anniversary. During the past 70 years, there have been significant research accomplishments and we have succeeded in producing many outstanding members of society.

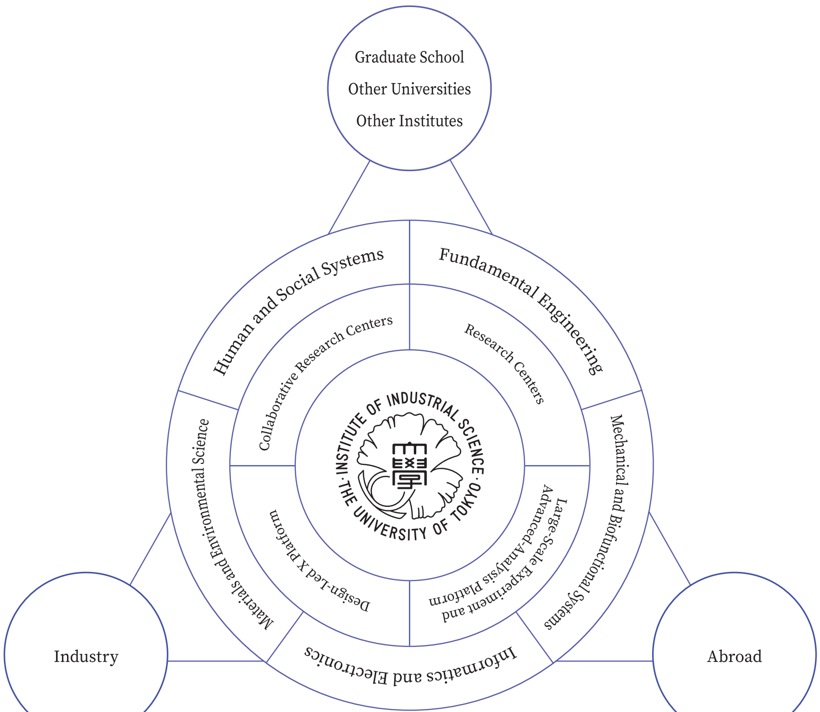
The UTokyo-IIS is a comprehensive engineering research institute that covers almost all fields of engineering, consisting of five research divisions. It has approximately 120 laboratories overseen by professors, associate professors, and lecturers. More than 1,200 personnel, comprising approximately 250 faculty members, 150 support members, and 800 graduate students and postdocs participate in educational and research activities that are responsible for producing excellent research outcomes and fostering outstanding talent.

Furthermore, there are 3 affiliated research centers that span multiple research departments, 7 internal centers, 2 collaborative research centers, and an international collaborative research center that pursues international joint research. In addition to promoting original research in specialized fields, each laboratory systematically engages in interdisciplinary or international activities by using organizations such as the cross-disciplinary research centers.
In 2017, the Chiba Experiment Station was relocated from its original site in Nishi-Chiba to the Kashiwa Campus, and since 2020, the facility is operating as a Large-scale Experiment and Advanced-analysis Platform (LEAP). In addition, a completely new facility called the “Design-Led X Platform,” the first of its kind, has also begun operations in 2017.

Since the foundation of the UTokyo-IIS, we have been acutely aware that the significance of academic research in engineering lies in its real-world implementation. Not only have we created new academic fields through enhanced specialization and collaboration across disciplines, but we have also developed and deployed technologies that can contribute to solving problems in the real world. In addition, we have made it our mission to develop individuals who will shoulder the responsibility of developing and disseminating technology in the industrial world.
The spirit and the sense of mission of the UTokyo-IIS since its establishment still live on, and we tackle various engineering-related issues in a practical manner as a pioneering organization advocating industry–academic collaboration.

Such achievements and such a proactive stance are widely recognized, along with the name *SEIKEN* (short name for IIS in Japanese).
We seek to create a new “*SEIKEN* style” as we continue to pursue academic truth as a university research institute, contribute to the creation of new value through innovation, and aim for a multidisciplinary approach integrating humanities and sciences for implementation in the real world.

Although the UTokyo-IIS is the largest university research institute in Japan, it maintains a strong sense of unity as an organization. Using its agility and comprehensive capabilities, the UTokyo-IIS will continue to fulfill its role as one of the world’s top research institutes in the field of engineering. We believe that we will continue to make great contributions to society through research and education.



Five Research Departments and Research Centers

Institute of Industrial Science, The University of Tokyo (UTokyo-IIS)
https://www.iis.u-tokyo.ac.jp/

Komaba Research Campus（Komaba II Campus）
4-6-1 Komaba Meguro-ku, TOKYO 153-8505, JAPAN
E-mail：koho.iis@gs.mail.u-tokyo.ac.jp

Kashiwa Campus
5-1-5 KASHIWANOHA KASHIWA-SHI, CHIBA 277-8574, JAPAN (Kashiwa Campus)
6-2-3 KASHIWANOHA KASHIWA-SHI, CHIBA 277-0882, JAPAN (Kashiwa II Campus)
E-mail : kashiwa.iis@gs.mail.u-tokyo.ac.jp

Publications
https://issuu.com/utokyo-iis

UTokyo-IIS Bulletin
Institute of Industrial Science,
The University of Tokyo

pro@iis.u-tokyo.ac.jp
https://www.iis.u-tokyo.ac.jp/