AIRC

Artificial Intelligence Research Center

AIST

AIRC center director
Junichi Tsujii

Smartphones, cleaning robots, self-driving cars…the move towards to incorporating artificial intelligence (AI) in all aspects of society is accelerating. While there have been a number of AI booms in the past, they were limited to laboratory research. Finally, the time has come when AI is being integrated within society.

AI has huge potential to help to solve various problems faced by the Japanese society, which is the first country globally to experience advanced aging. It is important to note that the role of AI is not simply to improve operational efficiency or to lower costs. Rather, AI will also take on the role of improving the quality of services in various industries.

For example, in the healthcare field, AI is capable of analyzing lung x-ray images and detecting signs of lung cancer that would escape human observation. As another example, AI is suited to quickly detecting problems that could affect the stable operation of power-generating windmills. In other words, AI is highly effective in detecting phenomena that have a tendency to be overlooked by humans. On the other hand, there are still many phenomena in society that can only be understood by humans. The “quality” of intelligence possessed by humans and AI is fundamentally different. The future of AI can be considered the exploration of methods to combine the two types of intelligence in order to solve problems more effectively.

Japan has a number of strengths with regard to AI research. One is its technological foundation in manufacturing. For example, we would have many advantages in research on self-driving cars since Japan has a few globally competitive automobile manufacturers which can share expertise with AI researchers. Precision processing technology in the manufacturing industry is similar. Moving forward, it is highly likely that AI will revolutionize the manufacturing workplaces which are the pride of Japan.

Japan also offers top-class global services in the fields of healthcare and caregiving. If the huge amounts of previously accumulated data and expertise can be shared using the latest technology, including big data analytics, it will become possible to offer advanced services in even more locations. This will result in possibilities to move towards healthcare plans that are increasingly personalized for the individual.

Furthermore, it must not be forgotten that Japan has cutting-edge research environments for science and engineering. If the enormous volumes of scientific knowledge collectively possessed by researchers all over Japan including businesses and universities, can be gathered in the form of data and linked with AI systems, it will surely bring about new societal innovation.

We want to create a “space” for open innovation that connects together industry, academia, and government.

Fundamental research into AI is advancing rapidly via rigorous efforts worldwide. This research extends to many areas, including machine learning, simulation technology, natural language processing, and development of computational architecture for AI. Japan also has excellent research organizations in industry, academia, and government. We believe it is our mission at AIRC to offer a “venue” for open innovation that connects the proprietary data and expertise in each of these areas. In the US, a leader in AI research, data and expertise are collected by private companies, and there is a fierce competition to acquire superior engineers. Because this is the current reality, we would like to present a model to the world of how a public organization coordinates AI technology. Only a public organization can take on the role of promoting the sharing of data that cannot be made public by businesses and universities. In addition, cooperation with overseas research organizations is essential.

To this end, we want to actively increase the number of foreign researchers that we employ and expand our horizons to carry our joint research with foreign organizations. Naturally, we are also putting effort into collaboration with domestic businesses. Currently we have formed a number of joint research teams with manufacturers, but we would like to further accelerate these efforts, with our vision being to encourage collaboration among companies. We believe that creating a “space” where manufacturers from various industries can collaborate even if only on fundamental technology, would be of huge benefit in improving AI technology in Japan.

PROFILE

Junichi Tsujii

He graduated from Kyoto University Graduate School in 1973, obtaining a PhD in engineering. He became Associate Professor at Kyoto University in 1973, Professor at Manchester University in 1988, Professor at Tokyo University Graduate School in 1995, and Principal Researcher for Microsoft Research Asia (Beijing) in 2011 before taking on his current position in 2015. He still holds a Professorship at Manchester University.

Concept

- •AI that can be embedded in the real world
- •AI that solves problems through cooperation with humans
- •AI that can explain things

The goal of research at AIRC is “AI that can be embedded in the real world.” In other words, the goal is to achieve AI that solves complex problems in society, in cooperation with people in the real world. We ultimately aim to implement AI in society in a diverse range of sectors, including the service industry and healthcare/caregiving services, in order to help boost industrial competitiveness and achieve a more abundant society. Accordingly, the role of AIRC is to serve as a core hub for promoting large-scale research, in collaboration with eminent and up-and-coming researchers in AI and related disciplines from Japan and worldwide.

Research strategy

Field I

Mobility

Utilizing AI in “global monitoring of the Earth” and “smart mobility”

After the time of motorization in the 20th century, human beings are searching for new forms of mobility with more “freedom and safety”. To this end, we build a multiscale framework to integrate all the geospatial information collected by diverse mobile agents, such as Earth-observing satellites, aircraft, drones, and the self-driving cars/robots. The raw geospatial data will be converted into semantic maps to support efficient navigation of the mobile agents. In this field, there are the two main research areas, i.e., “global monitoring of the Earth” and “smart mobility.”

[1] Global monitoring of the Earth — The innovative downsizing of Earth-observing satellites has realized “constellations” consisting of hundreds of micro-satellites. The resulting huge amount of Earth imagery must be automatically analyzed by AI instead of human eyes. In order to promote the commercialization, we are developing an intelligent system which efficiently collect beneficial information from the tremendous satellite imagery by automatic detection of any kinds of objects and events on the Earth.

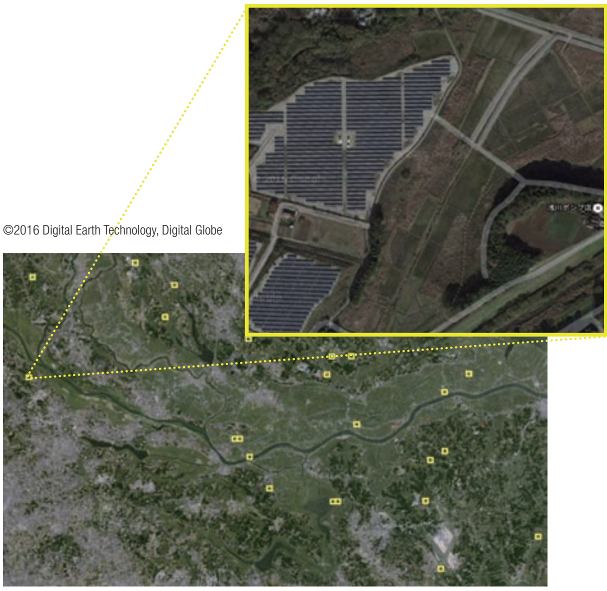
[2] Smart mobility — While self-driving car technology advances, coexistence with human drivers requires more “human-like” understanding of the surrounding situations. Self-driving agents must grasp accurate geospatial context in real-time through semantic mapping of their total environment. Research is being conducted to support their autonomous guidance and control by constructing dynamic 3D map.

In this field, technology is being developed in which machine learning is used to detect terrestrial features accurately from satellite images, as well as technology for automatically creating 3D maps using roving automobiles and autonomous mobile robots.

Theme

1 Automatic detection of terrestrial features using satellite images

Using machine learning and deep learning technologies, huge amounts of imagery received from Earth-observing satellites are analyzed in a fully automatic way. Not only will this enable specific features, such as solar power plants, to be identified, it can also help in detecting and understanding general changes from long-term satellite observations.

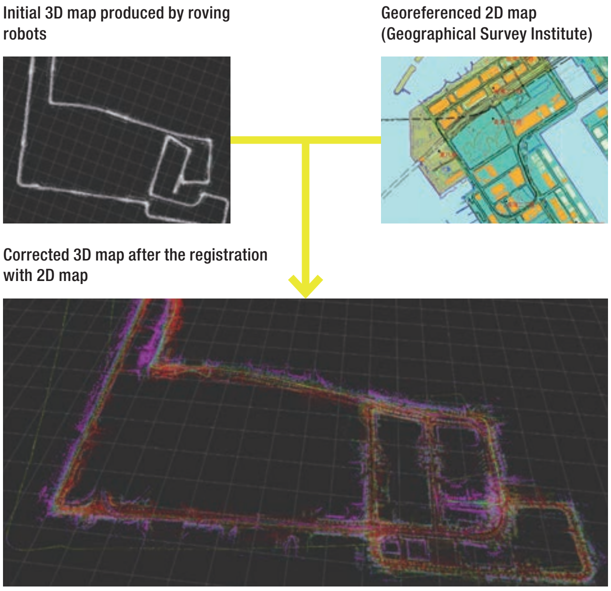


Note: This research is supported by the NEDO (New Energy and Industrial Technology Development Organization) project, “Core Technology Development of Next-generation AI and Robots.”

Theme

2 Automated 3D map generation from roving automobiles

New automated 3D map generation method is being developed that makes geometric registration of new observation points with the reference 2D map. This technology reduces accumulated “distortions” in measurement data, thereby producing more accurate 3D map. This is expected to be utilized for the commercialization of self-moving agents.



Note: This research is supported by the NEDO project, “Core Technology Development of Next-generation AI and Robots.”

Future prospects

- ▶ Development of the mixed-reality platform in which spatio-temporal structures of physical space is authentically transported to virtual cyber space
- ▶ Development of self-driving cars equipped with prediction systems of other vehicles' movement

Manufacturing industry

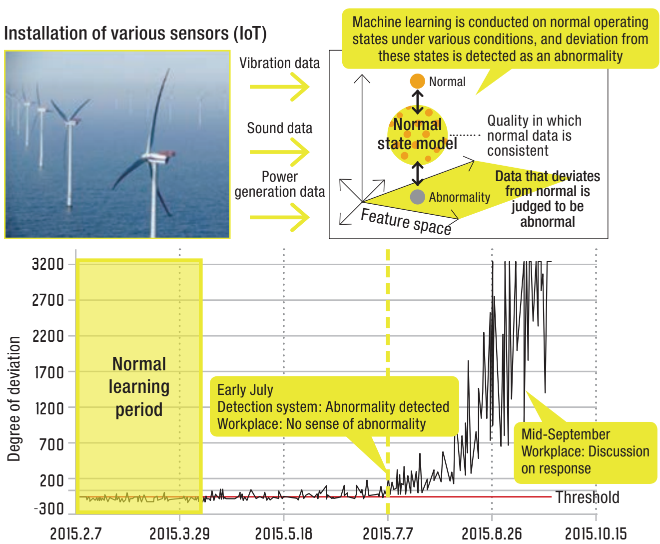
Improvement in quality and precision of manufacturing

The adoption of AI is moving ahead even in the workplaces for manufacturing that is the pride of Japan.
In mass production workplaces to date, machines with recorded operation procedures have been called on to repeat the same movements. Moving forward, as lower volumes of production for a greater variety of products become more common, the technology nurtured in these environments will begin being applied in other areas such as agriculture and the home. As this happens, machines will be needed that can respond to the situation more flexibly, and that can optimize the system.
To this end, technology will be needed that can automatically generate robot work movements. Research is being conducted on robots that can implement automated work process planning by presenting the final state of an assembly procedure. In addition, a simulated factory will be constructed that adds not only the situation but also processing procedure, as we work on understanding the operational state of moving machinery and failure prediction.
In this field, we have entered the verification testing stage using prototypes in the development of a system that detects signs of failures and danger in wind power-generating equipment, and that enables predictive maintenance. We are also developing technology to enable robots to handle objects without form such as towels or clothing in which their shape cannot be modeled beforehand. Here, the latest technology is used including imitation learning methods that utilize deep neural networks.
The potential of AI is moving beyond the role of achieving greater efficiency that has been the mandate of machines heretofore, and onto improving quality and accuracy.

Theme

1 Detecting signs of failures in wind power generation

A system is currently in development that uses machine learning to detect signs of equipment failure that would be difficult to detect from visual inspection. Currently, sensor data is being collected from 41 actual domestic large wind turbines, and large-scale verification testing is being conducted. The goal is for a paradigm shift from responding after the fact to maintenance that prevents problems and maintains safety.

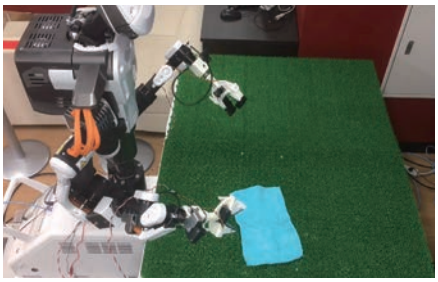


Note: This research is supported by the NEDO project, "Wind power generation advanced commercialization R&D/ smart maintenance technology R&D."

Theme

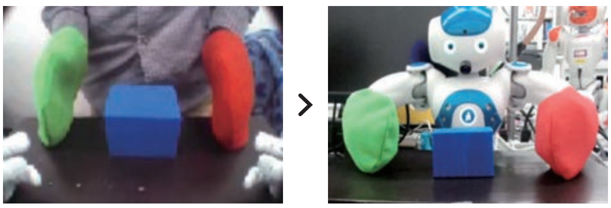
2 Imitation robot

We are developing "imitation learning method" that enable to learn the relationship between visual information and teaching motion, through end-to-end neural networks. And the method will enable motions whose teaching was difficult, such as picking up unknown objects, and folding of soft objects. A "teaching-less" robot is definitely not just a dream.



Achieving stable and repeatable folding motion of soft object

Note : This research is supported by the NEDO project, "Core Technology Development of Next-generation AI and Robots."



Robot reproduces motion by watching a person move a box up and down

Future prospects

- ▶ Expansion of breadth of failure and danger sign detection, and improvement in prediction accuracy
- ▶ Establishment of key robot technology and greater integration
- ▶ Creation of a robot that can appropriately respond to changing and complex environments and tasks

Service industry

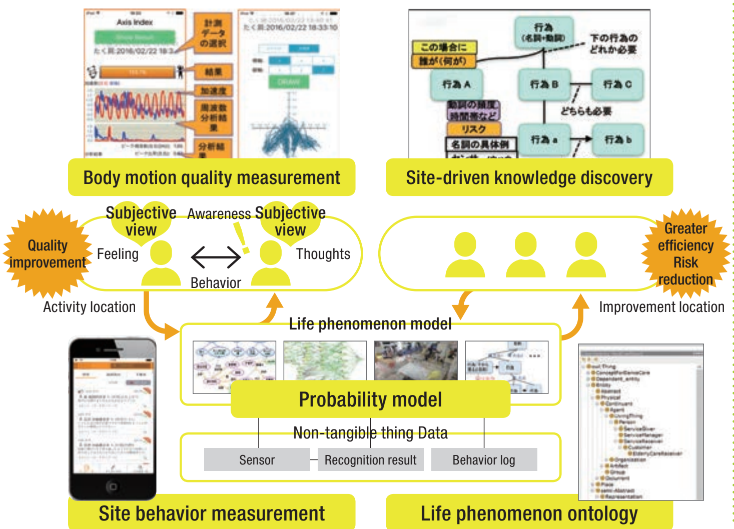
AI technology for transforming a product-based economy to a service-based innovation

In aiming for a society which creates new high-quality services that exceed existing concepts, it is essential to gather and analyze the experience and knowledge of people in the services industry and to develop a framework for improving and reconstructing operations. Compared to manufacturing workplaces such as factories, service industry workplaces for caregiving, nursing, and education, as well as places that promote health and create community through hobbies such as dance and music, are characterized by their large degree of freedom. For quality control of work in these places, there needs to be a change in knowledge from “tangible thing-centric” to “non-tangible service-centric.” Specifically, research is being conducted that gathers non-tangible things such as knowledge and awareness, and connects them to knowledge such as operational procedures and expertise in order to support greater operational efficiency. Research is also being conducted on using previously unobtainable operational big data in prediction and control systems. Using these technologies as a foundation, we are focusing on efforts to reduce labor and power requirements in simulated environments such as convenience stores through the use of AI and robots. In this field, we are also engaged in unique research such as the creation of an AI-supported framework that improves quality in service workplaces that create value through collaboration between people with advanced knowledge and skills. We will focus on how “non-tangible thing-centric” AI technology can contribute to improving quality in the services industry. In addition, there is also a movement to collect sensor data of healthcare and caregiving facilities in living laboratories inside and outside the National Institute of Advanced Industrial Science and Technology (AIST), and to build an open database. We look toward living laboratories serving as places for the development and verification of IoT sensing technology in service workplaces and living spaces.

Theme

1 Improving quality of on-site services and supporting creation of new services

Services with terminology and operational procedures that are heavily situation-dependent and differ from workplace to workplace will be standardized through ontological methods. This will increase compatibility between IoT and various AI apps, and lead to structure of operational knowledge and systematic collection of non-tangible things such as human behavior, meaning, feeling, awareness, and body motion.



Note: This research is supported by the NEDO project, “Core Technology Development of Next-generation AI and Robots.”

Theme

2 Development of “living function resilient service” using living labs

Living labs are open innovation environments for developing and evaluating AI that supports our everyday life in the real world. Life phenomenon data are collected from living labs inside and outside of AIST (children’s hospitals, senior homes, typical residences, etc.). We will analyze life phenomenon related to human physical and cognitive changes, and build an open database so that this leads to the creation of new services.

Children’s hospitals

Senior homes

Living labs for observing and recording life phenomena related to physical and cognitive changes

Note: This research is supported by the NEDO project, “Core Technology Development of Next-generation AI and Robots.”

Future prospects

- ▶ Improvement of services through change in perspective from a product-based to a service-based one
- ▶ Empowerment of services that use AI and robots
- ▶ Accumulation of operational knowledge in wide array of service settings, and support of improvement and reconfiguration

Field III

Health, Medical Care, and Welfare

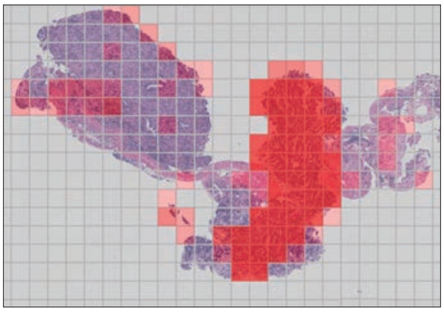
Leading-edge AI technology will change cancer diagnosis and drug discovery

Society is requiring the technology not only for medical treatment but also for preventive healthcare in order that people can live a healthy and long life. However, it is becoming the serious social problem that the heavy burden is placed on the doctors and paramedics with knowledge and advanced abilities.
To overcome this situation, we are actively working on the research of the medical engineering that will support doctors and improve diagnostic accuracy by using technology such as image processing and machine learning. We also challenging to develop the integrated support system for cancer diagnosis, e.g. the computer-aided detection system for breast ultrasonography.
In addition, through the development of new statistical methods with efficient algorithms, combinatorial factors causing genetic complex diseases become uncovered. Through collaboration with medical organizations, we have entered a stage of verifying the effectiveness of proposed technologies.
In addition, we are also focusing on supporting drug discovery that combines robot experiments and AI. Through AI and robot driven bio research, automated searches of diagnostic markers and lower cost individualized healthcare will become possible. This effort has been recognized globally, and in the Multimer Predictions category of the 12th Community Wide Experiment on the Critical Assessment of Techniques for Protein Structure Prediction (CASP 2016), AIRC was honored by being awarded 1st place worldwide.

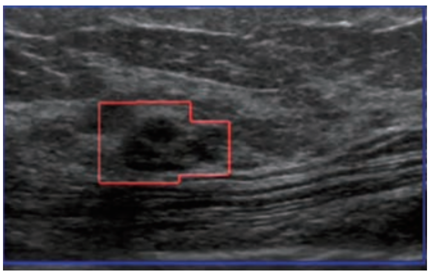
Theme

1 Computer-aided diagnosis in medical imaging based on machine learning

The advances in image recognition technology enable the machine learning system to support diagnosis in medical imaging. This technology is expected to contribute the great reduction of the burden on doctors and the improvement of diagnostic accuracy when it is used for screening and double checking. Specifically, a support system is currently under development that analyzes breast ultrasonography data and histopathological images to automatically detects suspected lesion .



The histopathological image diagnosis support software based on machine learning displays areas strongly suspected lesions (cancer) by the red marker.



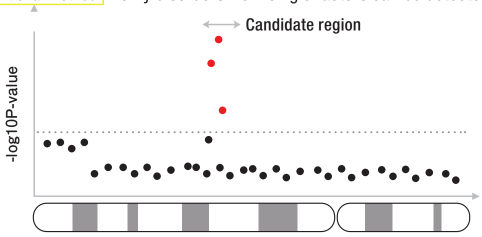
The breast ultrasonography examination support software based on machine learning automatically detects and displays the areas suspected as tumor.

Theme

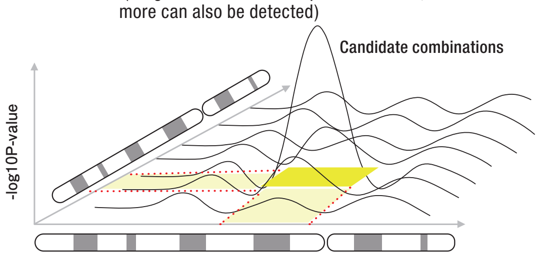
2 AI application to causal factor detection in genetic disorders

We are developing new techniques to understand the causal factors complex genetic disorders that to date have not been understood. Through the development of new statistical techniques with efficient algorithms, it will become possible to uncover factors caused from simultaneous genetic mutations. We will partner with medical organizations and conduct verification testing.

Conventional method Only disorders from single factors can be detected



Our method Disorders due to multiple factors can be detected (Diagram shows an example of 2 factors, but 3 factors or more can also be detected)



Future prospects

- ▶ Supporting technology for diagnosis and decision of course of treatment, based not only on genetic information but also on examination information and lifestyle information
- ▶ Drug discovery support that combines robot experimentation and AI

Field IV

Security and Safety

AI visual recognition technologies of surveillance to protect safety of our society

AI technology is playing important roles to keeping safety, security, and prosperity of our society. Video recognition and video explanation technologies provide accurate and ceaseless observation, which are required to keep safety in factories, hospitals, streets, and other locations in our society.
Our research of video-to-text translation with high precision visual recognition will be applied for smart vigilance cameras. Most of conventional methods cannot achieve accurate recognition, because they processed video information as a set of still images, not as a continuous time-series of images. Applying deep learning, our system is able to understand objects in videos and events occurring in videos accurately. In this way, AI's power of visual observation will provide support in various fields.
In addition, we are also applying technologies of large-scale pedestrian tracking and simulation to support safe guidance in crowded area and evacuation planning in emergencies. These technologies enable tracking of pedestrians by integrating numerous sensors and simulating behaviors of the pedestrians even in the case of a large event attended by 100,000 people or public spaces such as train stations or airport in real time. This is referred to as sensing and simulation technology. AI is becoming an indispensable technology for safety of social systems.

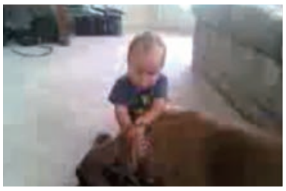
Theme

1 Video-to-text translation

Our AI system with deep learning technology generates sentences that explain the content and meaning of videos. Deep learning is utilized for recognition of objects and actions in video. Thanks to recurrent neural network (RNN), the system produces natural sentences for explanation.

Our system can recognize complicated features, such as gender of person, detail of actions and so on.

Conventional method
A man is drinking.
Our method
A girl is doing makeup.



Conventional method
A dog is playing with a dog.
Our method
A boy is playing with a dog.

Conventional method
A man is riding a car.
Our method
A woman is riding a boat.

Conventional method
A man is riding a bicycle.
Our method
A man is riding a bike.

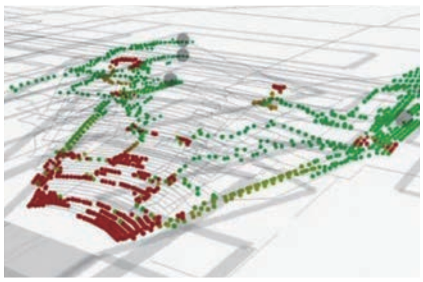
Note: This research is supported by the NEDO project, "Core Technology Development of Next-generation AI and Robots."

Theme

2 Evacuation guidance using AI

We were able to achieve visualization of the overall movements of a large number of pedestrians using real time pedestrian tracking technology and multi-agent simulation technology. Such visualization offers engineering techniques to design evacuation guidance, especially in cases of large numbers of people, whose overall movements have been difficult to recognize and have been controlled in ad-hoc ways.

Real time pedestrian tracking technology that uses stereo vision



Sensing and simulation technology that uses AI

Note: This research is supported by the NEDO project, "Core Technology Development of Next-generation AI and Robots." and the JST (Japan Science and Technology Agency) CREST project, "Comprehensive Architecture of Social Simulation for Inclusive Analysis."

Future prospects

► Connecting video explanation technology to specific applications in engineering, healthcare, and crime prevention
► Promoting societal use of pedestrian simulation

Field V

Other

Fundamental technology

Proposing new technology that supports and understands living scenarios

“Situational understanding” under various environments such as manufacturing workplaces, service industry workplaces, and the home is needed as a fundamental technology in the pursuit of co-existence of humans and machines. So AIRC is putting effort into research of 3D object recognition, movement recognition, and environment recognition.
Specifically, we are constructing 3D data of objects found in daily life and movement data of people, and proposing technology that comprehends and supports living scenarios. In addition, for the future we are exploring methods to apply this data to robot behavior planning.
In this field, we have established technology using deep learning that recognizes both shapes and functions of objects from 3D data. In addition, we have built a cloud-based virtual reality (VR) environment and are accumulating huge amounts of interaction data between humans and robots.

Theme

1 Interactive robots based on cloud-based VR

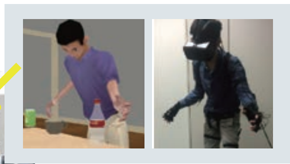
By building a cloud-based VR environment, a large-scale, long-duration interaction experiments using crowd sourcing have become possible. We are building a framework in which hundreds of people simultaneously participate in a 10,000-hour interaction experience, from which data can be accumulated and shared on the cloud.

Conventional method

Method using actual robot

- Accompanied by hardware problems
- Large cost in gathering test subjects
- Difficulty in sharing interaction experiences
- Conversational experiment limited to several hours

Log in



Our method

Method using VR

- No hardware problems
- Test subjects can participate without regard to time or location
- 10,000 hours of interaction experiences can be shared on the cloud

Note: This research is supported by the NEDO project, “Core Technology Development of Next-generation AI and Robots.”

Theme

2 Object recognition technology using deep learning

We have successfully developed new object recognition technology using deep learning technology that surpasses the accuracy of conventional methods while using only a small number of observed images. We won first place worldwide in the international 3D object retrieval competition SHREC 2017 for an algorithm developed for this research topic.

Deep Learning Robot

Conventional method		Our method
90% classification rate	>	92% classification rate
80 observed images		20 or less observed images

Note: This research is supported by the NEDO project, “Core Technology Development of Next-generation AI and Robots.”

Infrastructure, etc.

Building Global Artificial Intelligence COE

We are building a high-performance, green, and cloud-based computing environment that can widely be used in industry-academia-government collaboration for research and development of AI and IoT technologies. It will be built along with Global Artificial Intelligence COE that includes simulated environments of the real world for data collection and proof-of-concept. In this way, we will accelerate the social-implementations of AI technology.

AI Bridging Cloud Infrastructure (ABCI)

- Peak performance of 130 peta AI-flops or greater (floating point arithmetic performance at an accuracy suited for deep learning, such as half precision floating point)
- Over 315 TiB of memory, over 2.7 PB/s of memory bandwidth, and over 22 PB of storage
- Power consumption of less than 3,000 kW (projected annual average PUE of 1.1 or less)

SPEC

Researchers Opening up AI Frontier

AIRC attracts the top AI researchers in the world.
Here is an introduction of what is currently happening at one of Japan's leading AI research centers.

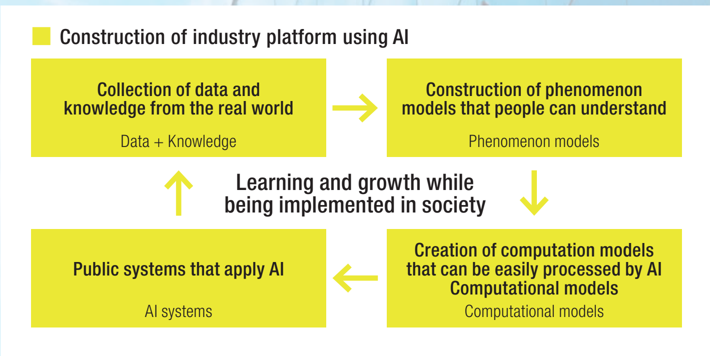
Lead researcher

Yoichi Motomura

Motomura has served as director of the Japanese Society for Artificial Intelligence, the Society for Serviceology, and the Behaviormetric Society of Japan. He specializes in next-generation AI research and probability modeling. He is specially appointed professor at Tokyo Institute of Technology, guest professor at the Institute of Statistical Mathematics, and guest professor at Tokyo University of Science.

SPECIAL TALK

01 Aspiring towards AI capable of mutual understanding with humans



Industry and living are being connected by AI technology, which is leading to big advances in business. What is this new age of AI in which manufacturing, distribution, and services are being merged together?

– Next-generation AI understands phenomena behind big data

It is said that the 3rd AI boom has now arrived. Driving this surge is a "machine learning" approach, and big data created by the Internet and sensors have made this possible. Via machine learning, AI is steadily recognizing images, space, and texts in this world. Deep learning has furthered advancement in image recognition, and space recognition from environment modeling is supporting self-driving technology. Natural language processing technology found in IBM Watson and Siri is expanding the possibilities of text recognition.

Furthermore, as we enter the IoT era in which sensors are installed in numerous devices and locations and connected via the Internet, there are expectations for AI to understand the phenomenon that lies within big data. An era has come in which AI has burst out from networks and phenomenon modeling has begun in the real world. If AI becomes able to recognize not only conventional Internet usage data such as search words and purchasing history but also subconscious behavior and patterns in daily living and business, society is bound to change greatly. What is important here is modeling technology that enables AI to understand phenomena. This will require a model in which humans can understand phenomena and AI can perform calculations. This will be essential in creating AI that solves problems through collaboration with humans, which is the goal of AIRC.

– AI will bring on the 4th industrial revolution

Implementing this technology in society is also an important mission of AIRC. The stages of AI technology implementation in society can be broadly divided into the following three categories.

1:Greater efficiency in existing operations and activities = Use of AI in existing services and methods.

2:Creation of new services = New services and methods made possible using AI.

3:Structural change in services and industry = Various services and methods that use AI are dynamically connected together.

We believe the path to this third stage as being the essence of the 4th industrial revolution.

While being implemented in society, next-generation AI will learn information from the real world and grow. The goal is to build phenomenon models that people can understand from workplace data and knowledge, and these will be accumulated as computational models that can be easily processed by AI. By creating a platform for industry, deployment and greater sophistication of AI, along with mutual collaboration will dramatically accelerate.

In this way if a dynamic connection is made between the Internet and real world, or between the cyber and physical worlds, unprecedented business opportunities will be created. If this spreads to all industries, there is no question that future society will become even more prosperous. Various areas of research are currently being conducted at AIRC including machine learning, probability modeling, service intelligence, and bioinformatics. Here is an introduction of our researchers.

Ryosuke Nakamura

Nakamura previously worked at the Japan Aerospace Exploration Agency (JAXA) before his current position. His specialization includes planetary science, satellite remote sensing, and satellite image processing using machine learning.

SPECIAL TALK

02 Completely understanding time-space of this world

Autonomous cars are becoming a reality in the 21st century. Human beings are searching for new means of mobility. Technology that supports next-generation mobility using AI is being created at AIRC.

- Recreating the real world inside computers

The seamless map that we have been working on is not only a terrestrial map but also a cyberspace map that seamlessly covers everything including indoors and subway station platforms. Our goal is to recreate the real world inside computers, so we are trying to construct an efficient mobility information platform from which the world's entire time-space construct can be understood.

Underlying this platform is the use of terrestrial observational data derived from artificial satellites, planes, and drones. Detailed city data derived from cars, autonomous mobile robots, and various indoor sensors is also added to this database. It might be easier to understand by imagining zooming in on a Google Map's satellite image and then switching to street view. Our goal is to create this in 3D and connect everything ranging from inside the home to the department store basement. If the seamless map becomes a reality, it would be a tremendous help to the mobility not only of people but also robots and self-driving cars.

- More simply recording the physical world

Everything above and below ground is currently being recorded moment by moment to prepare for the advent of an autonomous car society. This world has not only a space axis but also a time axis, so even recording the same location every second generates an enormous amount of data. If we had a technology that could analyze this image data and then categorize and textualize time-space being viewed by people, it would be very useful. You could say that we are searching for methods to more simply record the physical world using leading-edge AI technology.

One example is a technology that categorizes specific terrestrial structures by using deep learning. In the past, people used to look at satellite imagery and then specify map information on the computer individually, such as roads, schools, and factories. However, this method would not be practical to cover the entire earth. As an effective method, automatic learning is now conducted using deep learning techniques. Using pattern recognition technology, AI will automatically infer the significance of image data from the input data of satellite imagery and existing maps. This is a revolutionary breakthrough. In addition, once inputting period-separated satellite image data of the same area, AI will automatically recognize and explain what occurred over this time period. For example, AI can provide information such as "The location that used to be a school ten years ago is now a shopping mall."

- From Odaiba to the world

Moving forward, the era would come where maps are updated daily, as sensors equipped in self-driving cars worldwide record street-side data that is changing every second. This map data will be viewed not on smartphones or tablets, but rather on ski goggle-shaped wearable devices. While walking around town wearing these goggles, users might be provided information of nearby events by AI using satellite data, or be warned of observed abnormalities. This is probably an example of how the technology will be used. However, it would be difficult for this type of innovative technology to be quickly implemented in society. We would like to start testing in limited areas such as a farm or seaport. We want to collect data focusing on the Odaiba area where AIRC is located, and create a model for smart space mobility technology. We believe that this area—which includes the driverless Yurikamome train as well as the Tokyo Big Site exhibition hall and the National Museum of Emerging Science and Innovation (Miraikan), where leading-edge science and technologies are on display—is ideal as a testing ground. If possible, it would be great for AI to take on the role of guiding guests at the 2020 Tokyo Olympics and Paralympics. In addition, this technology is perfectly suited for applications in safety and security. Moving forward, we also want to put effort into research on AI that enables efficient evacuation guidance during emergencies.

To this end, we would like to actively collaborate with companies trying to create public infrastructure with new technology. By utilizing AIRC's network, we want to establish and spread a new mobility platform technology from Odaiba to the rest of the world.

The image on the left is an example of virtual space and real space being superposed and displayed. This is displayed in a goggle-type wearable device as in the image on the right. By displaying images of the same location superposed at different moments on the time axis, changes between the past and present can be understood.

SPECIAL TALK

03 Aiming for machine learning embedded in the real world

The machine learning research team is comprised of researchers in various areas of specialization including neural networks, Bayesian inference, and data mining. AIRC's deputy director spoke to two young people at the front lines of machine learning research.

- Conducting machine learning research in the place adjacent to applications

Asoh: AI and neural networks have previously experienced two booms in the past, and now it is said that the third boom has come. We are engaged in a broad scope of machine learning research including deep learning at AIRC. I myself started research in neural networks around 1980 prior to the second boom, and subsequently I have been conducting research in machine learning using Bayesian inference and data analysis. Prior to joining the center, what type of research were you two involved in?

Nagata: I have been involved in research of theoretical approach since my days as an undergraduate in the university. Specifically, I dealt with research that theoretically and mathematically analyzes how computer algorithms work. In my doctoral studies in the graduate school, my research topic was searching machine learning methods that can be universally used in natural sciences. I gradually wanted to do research in a location where the application of technology is emphasized, so I applied for a researcher's position at AIRC.

Asoh: There are researchers of various fields at AIST, and we have an environment where we can work together with researchers from companies, so I think it facilitates finding a path toward implementation of machine learning in society. By the way, what kind of research are you doing now?

- Machine learning has a wide variety including Bayesian inference, Markov chain Monte Carlo methods, tensor factorization, and so on.

Nagata: Fundamental research on machine learning using Bayesian inference. Going into a bit more detail, I am applying Markov chain Monte Carlo methods to a probability model using Bayesian inference in search of new data analysis methods. Recently, I have been developing organic catalysts jointly with AIST's Interdisciplinary Research Center for Catalytic Chemistry and Research Center for Computational Design of Advanced Functional Materials (CD-FMat). By combining test results—using this catalyst derives this type of chemical reaction and subsequently produces this amount of substance—with molecular simulation results, we are working to predict new catalyst reactions using machine learning.

Asoh: What kind of research are you engaged in, Hayashi?

Hayashi: Since my student days I have been studying neural networks and data analysis. Currently, I am doing research in data analysis methods using tensor factorization. This is a method of machine learning that uses the idea of matrices in mathematics, and can be regarded as a method of compressing huge amounts of data. For example, a chart that shows how Facebook users worldwide are interconnected can be expressed as a huge matrix such as 1 billion x 1 billion. The goal of my research is to make the matrix simpler by finding "coherence" that reflects regularity within the data.

Asoh: It is very important to find hidden grouping within data. Are you conducting joint research with companies?

Hayashi: I'm at the stage of exchanging information with AI related venture companies, but I would like to use AIRC's network to find a path to application. Among research topics being pursued in the center, I think "Understanding Cause of Genetic Disorders" (see page 8) is a good fit.

- What should researchers do in a world where machine learning has become ubiquitous?

Asoh: Do you have a future vision of what you would like to do at AIRC?

Hayashi: Of course I would like to investigate tensor factorization techniques, but as a researcher I am always thinking of what I can do in a world where machine learning has become ubiquitous. Machine learning technology will undoubtedly spread into society as an element of intelligent systems such as machine translation and self-driving cars. When that happens, decision making that had until now been the domain of humans will be taken on by machines. In other words, situations might occur where data generated from machine learning will be used by machine learning. What would happen then? Although it may seem like a sci-fi movie, it is possible to imagine an attack from malicious AI. I believe it is the responsibility of researchers like us to create robust and resilient social systems which can withstand such attacks.

Nagata: I also think machine learning and AI will be widely used in society. To this end, mutual understanding between AI and humans will become more and more necessary. I want to strive toward creating a framework in which humans can easily understand what machine learning is doing, as opposed to a feeling of AI being convenient but not well understood.

Asoh: This is precisely the realization of "AI that can mutually understand with humans" and "AI embedded in the real world" that AIRC is striving for. I'm expecting future success of you.

Hideki Asoh

AIRC deputy director. He previously worked at the Ministry of International Trade and Industry's Agency of Industrial Science and Technology (currently National Institute of Advanced Industrial Science and Technology (AIST)) prior to his current position. His specialties include neural networks and machine learning.

Kenji Nagata

He previously served as assistant professor at the University of Tokyo Graduate School of Frontier Sciences in the Department of Complexity Sciences and Engineering before his current position. His specialties include machine learning and Bayesian inference.

Kohei Hayashi

He previously worked as a special researcher at the Japan Society for the Promotion of Science and as a specially appointed assistant professor at the National Institute of Informatics before his current position. His specialties include machine learning and data mining.

SPECIAL TALK

04 This is the home of mixed culture!

At AIRC, there are also many researchers from foreign countries. What kind of future are they trying to create while engaging in various areas of research?

- Attracted by leadership of AIRC director Tsujii

Pascual: When I heard that Dr. Junichi Tsujii, who was my advisor during my graduate studies at University of Tokyo, had become the center director, it made me want to also join the team. Dr. Tsujii is well versed in industry and academia, so I was confident he would provide a stimulating and unique research environment.

Kristiina: I also know Dr. Tsujii very well, since he was my academic advisor during my doctoral studies at University of Manchester in England. When I learnt about AIRC and that it was recruiting, I immediately decided to apply. I feel very proud to be able to work under his strong leadership.

Nguyen: I was about to complete my doctorate at Keio University but still having many questions that I want answers. After considering many options including remaining at university to do research or starting my own business, I decided that the best way to deepen my knowledge was to work with outstanding people as a full-time researcher at a good institute. Coincidently, I found AIRC's recruitment, so I applied.

Seydou: After earning my doctorate at the University of Electro-Communications in Tokyo, I wanted to continue doing research in an industry oriented environment. This center, as a leading Japanese AI research institution that connects industry and academia, was the ideal place for me. Furthermore, research in AI presents challenges and perspectives that I am excited about.

Nguyen: To be honest, I didn't know much about AIST or AIRC when I applied. Where did you hear about them, Seydou?

Seydou: I heard about AIRC from a friend who was working at AIST's Tsukuba Center, and then I researched more on its website.

Nguyen: When I told my AIRC's acceptance notice to one of my esteemed advising professors at my graduate school, he was pleased, saying, "You got the best job as post-doc!" I was very relieved.

- Joint research possible with outstanding researchers from industry and academia

Kristiina: Currently, my research concerns social robotics, and I study the interaction between humans and robots. For example, the development of the WikiTalk robot application allows users to look for interesting information in Wikipedia via conversational interaction with a speaking robot. The conversation model is based on my CDM (Constructive Dialogue Model) approach which considers interaction as cooperative activity between two agents.

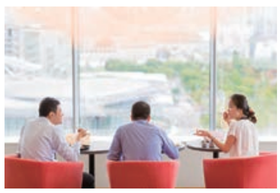
Pascual: I am also interested in the communication between humans and computers. Currently, my objective is to create AI that can understand human language and reason about the world. I am mainly involved in two projects. One project is on "Complex Q&A" in which AI uses large knowledge databases to answer complex questions. The second is in "Recognizing Textual Entailment" where our computers check whether what someone says is correct. We have recently developed the best logic system for this task.

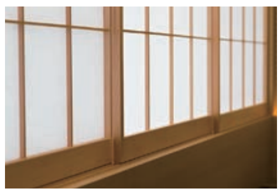
Nguyen: My major is in knowledge modeling and image/video analysis and search. At AIRC, I am doing a research on detection of visual inconsistencies within images and videos. This can be thought of as a support system for making creative products.

Seydou: I am doing more application-oriented research. Currently, with the NEC–AIST AI Cooperative Research Laboratory, we are working on deep reinforcement learning and simulation to develop an AI control system that can stand up to unexpected situations. Specifically, I am aiming to build systems that can work efficiently when faced with limited information or resources. I am happy for the opportunity to work with highly skilled researchers from industry and academia, and with varying fields of expertise.

Pascual: I also think that is one of the greatest strengths of AIRC. Many top

PHOTO GALLERY





Pascual MARTINEZ-GOMEZ ESP

His expertise includes natural language processing, machine learning and reasoning. He also has research experience in Germany. He is from Spain.

Kristiina JOKINEN FIN

She has experience as a researcher at Nara Institute of Science and Technology and at Advanced Telecommunications Research Institute International. Her specialty is dialogue modelling and multimodal human-robot interaction. She is from Finland.

Diep Thi Ngoc NGUYEN VNM

Her major is in knowledge modeling and image/video analysis and search. She is also interested in interdisciplinary knowledge integration. She is from Vietnam.

Seydou BA SEN

His expertise includes deep reinforcement learning, optimization and algorithm design, and communication networks. He is from Senegal.

researchers from industry and academia visit AIRC regularly and leading-edge information is constantly shared. That is stimulating and motivating. In addition, powerful computers, abundant resources and broad connections in industry and academia also support our research.

Kristiina: In my research of social robot interaction, cross-disciplinary joint collaboration is necessary. The high-quality research facilities and very active and inspiring researcher network at AIST have a huge value for this.

- Dynamic work-life balance and cheerful social gathering

Nguyen: I think AIRC is the home of mixed culture. People are smart and friendly and with a very good sense of humor. Working here everyday is full of fun and self-improvement. I also appreciate the flexible work environment. I had always had a negative impression of work customs in Japan, which include arriving early for work, long overtime, commuting in fully crowded trains, etc. However, the flexible time policy provided by AIRC has reduced all the above stress. On the contrary, I often prefer not going home–because doing research here is fun (laughs). How do you all feel about the work atmosphere?

Kristiina: The atmosphere is excellent. The research team I belong to has many interesting and thought-provoking discussions related to collaborative work. It is very exciting to be able to develop new technology while being surrounded by researchers with a wealth of knowledge in different fields such as ontology development, machine learning, knowledge engineering, pattern recognition, and biomechanics.

Seydou: The atmosphere is that you immediately feel as a member of the team. It is a friendly work environment in which we share our activities and interests during breaks, lunch time, and social gatherings. My research colleagues all speak English well, and they also bear with me with my imperfect Japanese (laughs).

Pascual: It is easy to initiate contact with teams in other fields within the center and conduct joint research. Researchers at this center tend to be open and proactive. Since I came here, I made many friends not only from Japan but many other countries, too. We go out for lunch and dinner together and talk often. There are a lot of restaurants in the surrounding Odaiba area.

- Future of AI research

Nguyen: My own view of AI is that it is for understanding ourselves, in addition to AI technologies for people. Through AI development, I want to address many important, yet difficult questions such as what does it mean to see, or the meaning of being a human.

Pascual: I also find interesting question of "what defines humans." My long-term objective is to create AI that understands humans and unleashes our potential. I want to create a natural interface that supports decision making in which AI operates as a brain using all of the knowledge of the Internet.

Kristiina: My goal is to create interactive AI that can talk with people, understand their behavior, assist them in everyday tasks, and provide them with useful information for instance about sports coaching, music instruction, and home caregiving support. This kind of communicating robot agent can surely make our daily lives more fulfilling.

Seydou: My goal also is to make people's lives more fulfilling with AI. By facilitating access to technology, it will surely be possible to improve social welfare. In the future, I would like to apply the expertise I gain from implementing AI toward furthering development of my home country, Senegal.

SPECIAL TALK

05 Working in an environment that facilitates application research

Young researchers at AIRC also have their own missions and are actively engaged in research. We spoke to four of them about their research in various fields.

- Joint research with major companies concurrently in progress

Yamazaki: My specialty is statistical theory, and recently I have been engaged in its application to automobiles. Specifically, I am working on driver modeling for a driver support system. Using in-vehicle sensors, we gather data on velocity, information on accel and brake pedals, and steering wheel angle, and then analyze these data based on machine learning techniques. The computer is made to understand driver psychological states and decision-making processes under various road conditions. Currently, I am engaged in joint research with automobile related companies. When I decided to connect theory with application, I found AIST's strong connections to industry was appealing.

Kanezaki: I also felt the importance of technology application, so I applied for a research position at AIRC. Currently, I am primarily engaged in the development of object recognition technology using deep learning (see page 10). 3D data acquired from Kinect and other sensors equipped in autonomous mobile robots is analyzed to recognize object shape and categories. It is something like 3D object pattern recognition using deep learning and I have already started joint research with companies.

- Transforming service workplaces using knowledge engineering

Nishimura: My specialty is knowledge engineering. This is a research field that garnered attention during the second AI boom. It can be thought of as research that enables AI to use the knowledge of humans. Currently, I am engaged in research to create a framework for improving operations in service workplaces using AI. For example, in caregiving work, the detailed operations vary in each workplace, therefore, it is difficult to create a common operation manual. By incorporating a framework that systematizes knowledge centered on workplace employees, I would like to help improve operations. I call this method "knowledge explication."

Ogata: Similar to Nishimura, I originally worked at the AIST Information Technology Research Institute and joined AIRC when it was founded in 2015. My work is to help transfer AI technology to workplaces in industry. At my previous position I also did work to pave the way for applying technologies such as pattern recognition, signal processing, and data analytics. My current research centers on detecting signs of problems in wind power generation (see page 6). This is the field of "smart maintenance" in which AI is used to detect abnormalities, and demand for this from manufacturing workplaces continues to increase.

- Presenting ideas during lunch meetings

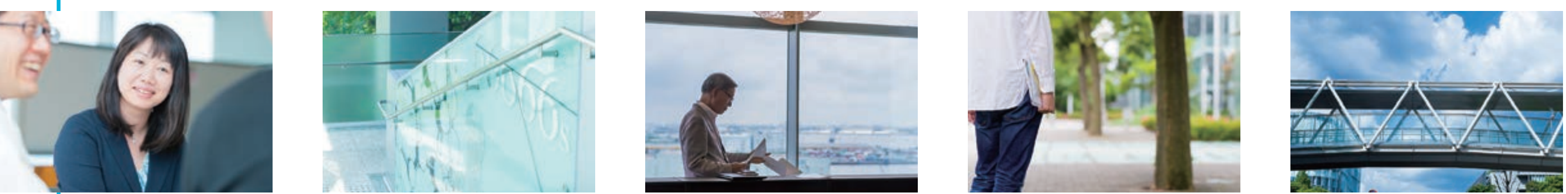
Kanezaki: How does research demand from business and government arise?

Ogata: There are cases in which we propose joint research with businesses, and other cases businesses come to consult with us. Recently in what is called the third AI boom, offers have been rolling in from major corporations that everyone is familiar with.

Nishimura: Joint research is flourishing not only with companies but also within AIRC. While there is division of roles with respect to keywords such as machine learning, probability modeling, and bioinformatics, there are many common points of research, so lateral connections between AIRC research teams are also smooth.

Yamazaki: Innovation coordinators also assist us to bridge research teams. In universities, research labs tend to be isolated, so I am thankful that we have the lateral network here.

Nishimura: Often times, we enjoy mutual presentation of ideas during lunch meetings in a frank atmosphere of "let's have lunch together since we work in



Keisuke Yamazaki

He previously worked as an assistant professor at Tokyo Institute of Technology. His specialties include Bayesian statistics and traffic flow analysis.

Satoshi Nishimura

He previously worked at the Human Informatics Research Institute at AIST before his current position. His specialties include ontology engineering, knowledge engineering, and linked data.

Asako Kanezaki

She previously served as an assistant professor at the University of Tokyo's Graduate School of Information Science and Technology before her current position. Her specialties include object recognition, machine learning, and intelligence robotics.

Jun Ogata

He previously worked at the Information Technology Research Institute at AIST before his current position. He has a doctorate in engineering. His specialties include spoken language processing, and acoustic and vibration analysis.

the same building." For example, today a researcher from overseas presented us her recent research.

Kanezaki: Where does this take place? I'd like to participate in the lunch meeting, too.

Yamazaki: Of course you are welcome to join. There are also many people who join after seeing our lunch meetings and wondering what is going on. Lunch time is easier for people to get together.

Nishimura: There are many manufacturing engineers and researchers sent here on assignment from companies. I think this is an attractive environment because there are people close by who have come in contact with various data gathered in their industry workplaces.

Kanezaki: I am primarily involved in fundamental research of deep learning, so it is a good opportunity to work with people who have more experience in application research, and it is exciting to exchange ideas.

Ogata: At AIST's Tsukuba Center, there are researchers not only of AI but also various other fields. Personally, I would like to see much greater research interaction across different fields.

PHOTO GALLERY

Yamazaki: It is an important point to be able to share the latest technical information. In fact, Nishimura and I have been engaged in heavy information exchange.

Nishimura: That's right. I will ask if Yamazaki's probability model can be used with knowledge representation data I acquire from caregiving workplaces in order to conduct analysis.

Yamazaki: The important point is "AI that can explain things." I would like to work toward a situation where data acquired from machine learning can be interpreted so that AI won't be a black box. In such a situation, there are absolutely no barriers of research fields.

- Achieving greater sophistication while implementing AI in society

Nishimura: Machine learning and deep learning are currently in the spotlight, but there are still many phenomena in the world that cannot be understood even after analyzing big data on the Internet. Operational improvement of niche workplaces within the service industry on which I am researching is one example. I think the ideal AI must be one that can be easily used by people in the workplace and that can provide useful knowledge on the spot.

Ogata: I've been working with the team that focuses on technology application and doing a more workplace-oriented approach. One thing I always keep in mind is that AI may become meaningless unless it can be easily used by ordinary people. As for failure detection of wind power generators on which I have worked, we use machine learning to analyze data from actual equipment at wind farms nationwide. I want to create a framework that reflects the views of people in these workplaces.

Yamazaki: I think that is an ideal cycle of increasing AI sophistication while implementing it in society.

Ogata: I welcome an era when the image of AI being difficult to understand is shed and when AI can be actively nurtured by people in the workplace. Nishimura, do you have an ideal situation for AI in service workplaces?

Nishimura: From my perspective, it would be ideal for AI to be incorporated into workplace operations and for it to naturally become more sophisticated as a result of interaction. I also expect data and advice presented by AI systems to change the behaviors of employees and improve operational flow. Kanezaki, do you also have a vision for the future?

Kanezaki: I have an interest in machine autonomy. Specifically, I would like to create an intelligence in an autonomous mobile robot using technology such as deep learning. The history of human technology can be thought of as the history of automating processes that humans can do. I would like to surpass this and create AI that can think on its own and act. This is very possible using today's technology. I would like to achieve things that have not been thought of before and give them back to society.

Yamazaki: I see, very interesting! I have long been involved in statistical theory research, but jumped into the application research field. I would like to further pursue theory in a place close to where technology is being implemented in society. Fundamentals and application tend to be regarded as different things in university research labs, but I would like to do both ends at the same time. I think AIRC is the only place where both fundamentals and application can be pursued in a leading-edge research environment.

Ogata: As someone involved in technology application, it is my intention to connect people's dreams to real life. To this end, I would like to see more unique young researchers join our research.

SPECIAL TALK

06 Creating a new field that combines simulation and AI

At the NEC–AIST AI Cooperative Research Laboratory, which was founded in June 2016, there are researchers not only from NEC, but also universities. What research is being conducted at this laboratory that features collaboration between industry, academia, and government?

- Using Simulation to cover the areas with limited data

Tsuruoka: The NEC–AIST AI Cooperative Research Laboratory is drawing attention as a place that aggregates the experience of company and university researchers together with the research expertise of AIRC. Dr. Washio, you have been at the lab since its inception in 2016, right?

Washio: When I was invited to participate by AIRC, I was interested in the theme of how to deal with various problems by combining simulation with AI technology such as machine learning. And I was surprised to learn that private companies had a need for the areas with limited data, not for big data.

Tsuruoka: If we had to deal with the theme of analyzing big data with deep learning, we don't need to stick to work at the lab with collaboration between industry, academia, and government.

Washio: There are three main projects that are currently under way at NEC–AIST AI Cooperative Research Laboratory. One is the convergence of machine learning with simulation. This research project aims to understand complex societal phenomena and to search for solutions to problems, by using simulation technology to cover low probability phenomena such as disasters and unknown situations, in addition to big data analysis of phenomena that occur on a daily basis in our society. This is an attempt to utilize engineering solutions derived from this project to build livable cities and consider flexible countermeasures during emergencies.

Tsuruoka: The second is my research theme, the convergence of automated reasoning and simulation. Through programming and inference using a simulator, we conduct a problem cause analysis and countermeasure deliberation, and present a solution in a format that people can understand and execute. The goal is to apply this method to a technology that supports operation of complex and dynamic systems, such as large-scale plants or IT systems.

Washio: The third is cooperation between AI and autonomous systems. When self-driving cars become a reality, if all AI were to make decisions in a self-centered manner, traffic congestion could worsen rather than be eliminated. I believe that research on "compromise" between AI is needed. The research has not started yet, but I think algorithms developed here can be applied to various scenarios in society such as in coordinating the production activity of a company. A common point underlying these research themes is to create algorithms with machine learning, while using a simulation method in the cases of events or locations with limited data.

Tsuruoka: For example, there is the Japanese saying, "When the wind blows, barrel makers make money." It starts with the phenomenon of the wind blowing, and through a series of inference steps, it eventually leads to the conclusion that barrel makers make money. Inference based only on symbolic knowledge is something fragile. In theory it could happen, but in reality, it will not. Here, theory is augmented by combining a model that can be realistically recreated. The idea is to augment theory with simulation. Using this method, we would like to create AI that supports operations, for example, at a plant. If AI were able to understand the details of plant operation using simulation technology, when a problem arises, AI would be able to explain why it occurs. In addition, it should probably be able to present a solution, such as by indicating that "Recovery is possible by following this procedure."

Washio: The important point is it can provide an explanation. AI currently has aspects that are like a black box. "AI that can provide explanations" is the goal of AIRC as technology that can provide the answer to the question "Why did that result occur?"

- Aiming to apply "generic" methods in all social scenarios

Tsuruoka: Joint research with NEC is the first example, and there are many companies approaching AIRC in this field. At universities, there are a number of joint research projects being conducted with companies, but I think it is difficult to find a joint research project of this scale.

Washio: Currently, we are engaged in research with over 10 team members per project. It would be difficult for not only a university but probably even for a company to achieve this scale. I think AIRC can be a major player in this situation. At our research lab, we have many visiting researchers not only from the University of Tokyo and Osaka University but many other universities as well. This has resulted in broadening the scope of research themes.

Tsuruoka: From the perspective of researchers, the strength of AIRC is its attractive environment for AI application development. For example, with this collaborative lab, if there are excellent ideas, NEC will apply them in production workplaces or public projects with abundant knowledge and experience.

Washio: Our goal in this environment is not to solve niche problems of businesses, but to develop generic and powerful methods and to apply them in all aspects of society. I think the NEC Central Lab also regards this place not only as a company lab but also as a research base that is seeking lateral tie-ups in industry.

Tsuruoka: I would like to invite young researchers and students, and make this lab a place to develop talent for all industries.

Washio: I think there are very few research institutions even worldwide that aim to solve problems, at this scale, in the areas without much data, by combining simulation and AI technology. I would like to pursue research topics that nobody has thought of yet, and to produce world-first research results.

Takashi Washio

He completed his doctoral studies in the Department of Nuclear Engineering at the Tohoku University Graduate School of Engineering. He was previously assigned as a guest researcher at Massachusetts Institute of Technology and a senior researcher at Mitsubishi Research Institute before becoming a professor at the Osaka University Institute of Scientific and Industrial Research. As an AIST special fellow, he is also the Collaborative Research Lab Director.

Yoshimasa Tsuruoka

He completed his doctoral studies in the Department of Electrical Engineering and Information Systems at the University of Tokyo Graduate School of Engineering. He previously worked as a researcher at the Japan Science and Technology Agency and as an associate professor at the Japan Advanced Institute of Science and Technology before becoming an associate professor at the University of Tokyo Graduate School of Information Science and Technology. As a resident researcher at AIST, he is also Collaborative Research Lab Deputy Director.

We are also accelerating collaboration with private enterprises and overseas research organizations!

AIRC wants to serve as a bridge for AI technology through joint research with businesses. We have established AI collaborative research labs with certain companies, and we are actively seeking tie-ups with joint ventures.

Achievement

Other activities ↙

1 >> Business collaborations

- We are joint research partners with over 40 private businesses.
- In addition to establishing the NEC–AIST AI Collaborative Research Lab and the Panasonic–AIST Advanced AI Collaborative Research Lab, we are also working toward opening a joint research center with businesses.

https://www.ith.aist.go.jp/

NEC-AIST AI Cooperative Research Laboratory

2 >> Partnerships with large-scale public projects and research organizations

- **SIP (Strategic Innovation Creation Program)**
  We have partnerships in infrastructure maintenance and autonomous travel (dynamic mapping).
- **Other research organizations**
  We have a joint research partnership with the National Cancer Center Japan.

3 >> Stronger partnerships with overseas research organizations

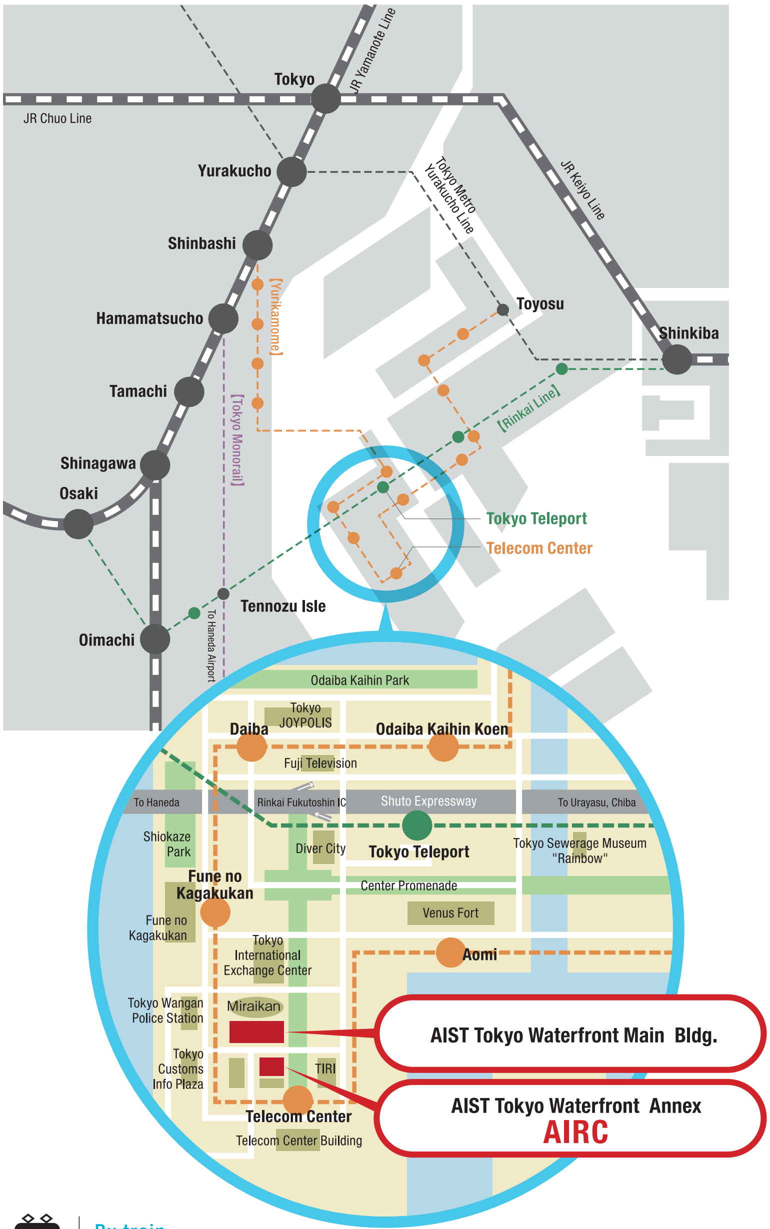
- We are strengthening ties with overseas research organizations such as University of Manchester, German Research Center for Artificial Intelligence (DFKI), Carnegie Mellon University, and Toyota Technological Institute at Chicago.

4 >> AI technology proliferation and human resources training activity

- AI technology consortium http://www.airc.aist.go.jp/consortium/
- AI seminars and workshops https://airc.doorkeeper.jp/
- International symposiums, joint symposiums with Nikkei
- Venture outreach committee
- AI startup workshop
- Participation in Next-generation AI and Robot Core Technology Development Private Exhibition
- NEDO–AIRC–The University of Tokyo AI Talent Development Course
- NEDO–AIST joint symposium, "Core Technology Development of Next-generation AI and Robots."

AIRC

ACCESS



By train

- 3-minute walk from the Telecom Center Station on the New Transit Yurikamome Line
- 15-minute walk from the Tokyo Teleport Station on the Rinkai Line

By bus

1. Take the Toei Umi01 bus from the Rinkai Line Tokyo Teleport Station or the Monzen Nakacho Station on the Tozai or Oedo subway lines
2. Take the I No.30 or I No.32 Keikyu bus from the west exit of Oimachi Station on the JR Keihin Tohoku Line.
3. Take the Mori No.30 or Mori No.40 Keikyu bus from the east exit of Omori Station on the JR Keihin Tohoku Line.

→Get off at the Telecom Center Station stop, and walk for about 5 minutes.

From Haneda Airport

Take the monorail from the airport

→Transfer to the Rinkai Line at Tennozu Isle Station → Get off at Tokyo Teleport Station and walk 15 minutes

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