[1st Featured Article]
Transforming Infrastructure Maintenance, Disaster Response, Manufacturing, and Services!

Future Society with Robots and Drones

[2nd Featured Article]
AI That Can Enrich Human Life
Perspectives on Future Technologies
Naoko Yamazaki, Astronaut
Breakthrough Will Assuredly Happen

Naoko Yamazaki, Astronaut

Although the development of outer space technologies in the real world hasn’t always kept up with the pace of 2001: A Space Odyssey, some advances, such as communication speed and computer miniaturization, have far outpaced those of the film. Space technology draws on a wide variety of fields and includes many types of technology from different sectors.

In particular, robotic technology is essential. I had done research in robotics control as a student, and I have believed there is no future for space development that does not utilize robots. For example, the International Space Station, a massive structure, was assembled using robot arms because it was impossible for humans to do the necessary work alone. As I was involved in this kind of work in space, I strongly felt the importance of the cooperation of human beings and robots. This relates to reliability and safety.

In the past, we have engaged in research in industrial robots for the purpose of these machines working independently or in deserted or uninhabitable places on earth, and in recent years, robotics research has also started focusing on applications that can assist humans to improve their lives. In space, however, the cooperation between human beings and robots has long been emphasized since all work happens on the International Space Station, a different environment with astronauts and robots working together. Going forward, the trajectories of human-robot relationships will align both in space and on earth.

In 2020, Japan will host the World Robot Summit, where the people involved in robotics from all over the world will gather and compete in robot technology. Although the summit is nominally a competition among robots, I think the barriers between humans and robots will gradually decrease as the capabilities of both continue to expand.

Technology can be improved incrementally when we see it as an extension of an existing technology. However, in order for innovations to happen, it is important to look ahead a generation or two. Breakthroughs will happen even for technologies currently considered outrageous and dreamlike. When that happens, how not only the technology but also the legal, ethical, and social structures of our society be changed alongside them? As the technology advances in the fields of space technology and robotics, I would like to shift my focus on soft power and ideas for how to get more people to utilize these technologies.
Robots and drones helping to mitigate the effects of population decline

Currently, the Japanese population is aging at the same time that the birthrate is declining. The population peaked in 2006, and has been steadily decreasing since then. In particular, the productive-age population, defined as being between 15 and 64 years old, is predicted to decrease significantly (Figure 1) in coming years. Maintaining productive capacity is a serious issue for the nation.

Additionally, much of Japan’s infrastructure, such as bridges, tunnels, and dams, was constructed more than fifty years ago, and it will soon become necessary to take measures to protect against deterioration. Moreover, natural disasters, such as earthquakes, occur frequently in Japan, so minimizing the human and economic damage from these events has been a longstanding challenge.

The utilization of robots and drones has recently drawn attention as a possible solution to these issues. They are expected to not only take a supplemental role in work, but also eliminate the need for human labor in dangerous and difficult tasks, solve the labor shortage problem, and improve overall safety and efficiency.

Expectations for robots to contribute to economic growth are high as well, and this reflects predictions for market expansion in this field (Figure 2). It is said that we are entering a “Industrial Revolution 4.0” created by the technology innovation of robots and artificial intelligence (AI), following the mechanization of factories, mass-production made possible by electric power, and automation using information technology (IT). This trend presents a great opportunity and a critical role for Japan which has been known as a “robotics superpower” to lead the world.

The Japanese government has been promoting the advancement of the robotics field through such policies as “Japan’s Robot Strategy.” In the “Future Investment Strategy 2017” approved by the Cabinet in June 2017, promoting the utilization of next-generation robots is specifically listed as a measure. The strategy also sets quantitative targets including expanding the domestic robotic production market, in both manufacturing and non-manufacturing (such as services), to 1.2 trillion yen by 2020.

Challenges for not just developing the technology, but socially implementing it

In addition to the existing robotics technology development, NEDO has started to work on a new effort that will go one step further and ensure that the technology is successfully translated into society. “Previously, NEDO has focused on technology development, such as increasing the sophistication of performance and structure, and people have become familiar with robots,” said Ryosuke Aya, Director of NEDO’s Robot and Artificial Intelligence Technology Department. “Moving forward, in this new stage, NEDO will go one step further to engage in projects to aim for societal implementation,” so human and robots will one day coexist and work together to solve social issues. Some examples include establishing a mechanism to evaluate robots’ performance, and contributing to an international standardization of robots, which has not been established yet.”

Following are highlights of NEDO’s vision of a future society with robots and drones, including the specific efforts by NEDO to utilize robots and drones in the fields of “infrastructure maintenance,” “disaster response,” “manufacturing,” and “services,” and the challenges involved in advancing the societal implementation of this technology, such as human resource development and environmental optimization.

Figure Society with Robots and Drones

Society has high expectations for robots and drones to successfully solve the issues that will arise in our future society. NEDO has been working on projects to accelerate technology development in anticipation of someday translating these advanced technologies into applications for everyday life. In this article, a vision for a future society in which robots and drones are utilized for many tasks is highlighted, along with NEDO’s current projects in various fields.
Done through NEDO Projects

**Technology Development**

Promoting solutions foraging bridges and tunnels

Streamlining the human work of visual inspection and drawing by hand

**Societal Implementation**

Streamlining data-collection and management by using robots

Japan has an increasing number of bridges and roads built more than fifty years ago. To maintain this infrastructure, Japan needs funds and experts. Shortage of both finances and engineers is a serious issue, especially for local governments, which own approximately 70% of the more than 700,000 road bridges around the country. NEDO has partnered with businesses and local governments to promptly realize a future society in which robots and drones are utilized to support the efficient inspection of infrastructures such as bridges, tunnels and dams.

One example of these efforts is a demonstration test conducted at a bridge in the city of Kawasaki, Kanagawa Prefecture, as a part of NEDO’s “System Development Project to Address Social Issues Such as Infrastructure Maintenance, Management, and Renovation.” The test used the iXs Research Corporation’s “Robot System that Can Perform Close Visual Inspection,” which it jointly developed with FUJIFILM Corp. The robot is hung down from bridge girders and has a double-lens camera, so it can identify the degree of the damage, width of the cracks, and the location of the images on the bridge. Instead of having a worker do this inspection, the robot collects detailed images and stores them, along with location information, to the database.

“Bridges are built at a high altitude, so when they are inspected by human it takes significant amount of time and cost to set up and take down the scaffolds, and traffic needs to be blocked for an extended period of time,” explained Fuminori Yamasaki, CEO of iXs Research. “By having a robot assist with the inspection, although it takes time to collect the images thoroughly, the data can be sorted out just with one click of a button, so the total operation time can be reduced dramatically.”

Hiroaki Kikuchi of FUJIFILM explains the imaging function on the camera, which substitutes for human eyes. “The camera has a high definition camera and bright light, so damage can be spotted even under dark conditions, such as behind the bridge,” he said. “The camera can detect cracks as narrow as 0.1 mm, which is minimum requirement for inspections. By using a double-lens camera, the width of the cracks can be calculated as well.”

“We used to use a special scale to measure cracks, and then we hand-drew a sketch for the report. By using a robot, we can save labor, which has been well-received so far. Additionally, by storing the data collected by the robot, we can gain better understanding of the progressive degradation, so we can utilize the robots for pre-repair work,” said Tomoyuki Yaguchi, Kawasaki City Construction and Greenery Development Bureau Roads and Rivers Development Department Road Facility Section Manager, who is optimistic about the technology’s practical applications.

Connecting businesses, local governments, and ministries and agencies to step forward

“The most important thing in infrastructure maintenance is to reliably collect inspection data. In designing these robots, we prioritized the needs and usability of the users on site, and ensured easy operation; this way, we’ve created a product that’s actually useful and isn’t just self-congratulatory for the manufacturers,” said Yamasaki of iXs Research.

“Currently, the robots are used to assist human instead of to substitute for them. However, NEDO believes that it is NEDO’s role to show that robots can be useful at the inspection site, and facilitate regulatory actions by collaborating with the appropriate ministries and agencies. This demonstration is a great example for us to use in showing that the robots can have practical applications,” said Yoshichika Uchiyama, Chief Officer of NEDO’s Robot and Artificial Intelligence Technology Department.

Since types and conditions of the inspected bridges vary, there have been efforts to develop drones that can keep their altitude relatively stable in the air when inspecting different shapes and types. NEDO also has ongoing projects that will make possible safe maintenance of various infrastructures, including a robot that assists in dam degradation inspection by taking pictures of dam bodies using an underwater camera.

Collecting information about disaster situations via drones

Explosion-proof robots navigating inside tunnels

When natural disasters such as earthquakes, volcanoes, and landslides occur, it is important to minimize the damage as much as possible. Especially at inaccessible sites, where people can’t enter because of the danger of a possible secondary disaster, remote situation assessment provided by drones and robots can be very effective. In this case, the Landslide and Volcano Disaster Situation Assessment Robot, developed through a NEDO project, can create a 3D map instantaneously by using a drone (multi-copter) to take images from the air, as well as collect land samples by using a land sampling device. The collected information can be used to develop rescue strategies and determine alert levels.

The demonstration test, conducted at Fugen-dake, Mount Unzen in Nagasaki Prefecture, was highly acclaimed by the Ministry of Land, Infrastructure, Transport and Tourism.

The rescue efforts for disasters caused by tunnel damage can be difficult because of the danger from inflammable gas. To assist with this, an exploration robot that can substitute for humans and perceive the state of the damage and the levels of gas has been developed. The robot has also received an explosion-proof certificate for the first time for a mobile robot. It can be radio-controlled, and in a closed space such as a tunnel, it can be remotely controlled using an optical cable from as far as 1,000 meters away.

By using a robot to gain understanding of damage more quickly and accurately right after a disaster happens, NEDO aims to minimize the human and economic damage of these events.
Aiming for an “easy to use” technology for both “niche” and “general purpose” applications

Japan is the world-leader in both the number of shipment and units in operation for industrial robots. However, the implementation cost for these specialized robots is high, making it difficult for small and medium-sized businesses to fully utilize them. To meet the specific needs of small and medium-sized businesses, NEDO has focused on developing unique robots specialized for niche manufacturing purposes.

Another approach is to develop general purpose robot systems. By introducing new standardizing technology that will increase versatility of the “platform robot” – for example, having a single common arm part, and customizing the picking part according to the intended purpose – more companies will be able to purchase robots at a lower cost. With the key words “easy to use” in mind, these robots could become valuable contributors to the manufacturing sector.

Recognizing clothes with image recognition technology and folding them with robot arms

In service fields (non-manufacturing fields), human workers can reserve their labor to the work and activities of a higher value, by utilizing robots for the simpler work that robots can handle effectively.

NEDO has awarded grants to develop a “fully automated clothes folding machine” as a part of “Promotion of Market Implementation by Applying Robotics.” The “Laundroid” was developed by seven dreamers laboratories, inc. in collaboration with Panasonic Corporation and Daiwa House Industry Co., Ltd., with a projected launch by the end of FY2017. Clothes are inserted in the box at the bottom of “Laundroid,” and the image processing technology and robot arms work together to fold the clothes, sort them by clothing type or owner, and store them accordingly.

This development project has improved the technologies used to assess and control the movement and status of clothes with the image processing technology, as well as the technologies used to handle soft objects that can easily lose shape. “We started development in 2005, and now finally we can see possibilities for this to be used in everyday life,” said Hiroshi Kitagawa, a member of the robotics of seven dreamers laboratories. “This robot has three key technologies: image analysis, which works as eyes; AI, which determines which individual the clothes belong to; and robots, which works as hands to fold them.

In the future, we would like to realize an ‘online closet,’ a system that simultaneously operates a dryer, creates data of all clothes stored in the closet, and suggests new outfits in addition to folding the laundry.”

“The robot makers have already worked with home appliance manufacturers and home builders,” said Noriko Kimura, Chief Officer of NEDO’s Robot and Artificial Intelligence Technology Department, expressing her high expectations. “I believe the market for utilizing this development is large, not only in individual households, but also in hotels and the apparel industry.”

There’s More!

The Road to Social Implementation of Robots

As new technology penetrates our society and becomes useful, a wide variety of issues other than just technology development need to be solved. Here are some efforts conducted by NEDO that fall under four key words.

Human resource development

To make use of robotic technology in society, we need people who can create innovations in robotic technology. To cultivate leaders who can create robotic businesses in the service industry, NEDO started the “Robot Service Business School” in 2016. In the first year, NEDO provided e-learning courses. Starting in April 2017, NEDO has provided lectures and small group workshops for problem-solving on design thinking, technology, and management of technology.

Robotics, a technology that has at times in Japan (see table), A wide variety of participants, from the business persons in charge of robot businesses in their companies to the workers involved in innovation education, are taking these courses.

Performance evaluation

In order for robots and drones to be widely utilized, users must be able to recognize and understand the performance of the product. To this end, NEDO has been working on an effort to establish standards for evaluating robot performance. Specifically, NEDO has set an ultimate goal of establishing an evaluation axis for performance and safety needed to operate drones, land-based robots and underwater robots, identifying performance levels according to the evaluation axis, assessing testing methods, and exploring standardization strategies.

At the Fukushima Robot Test Field, which is being developed by Fukushima Prefecture, NEDO demonstrated a long-distance package delivery by an automatically controlled drone for the first time in the world, in order to evaluate the performance of the drone.

Environmental improvement

Not only in aircrafts safely operate under the global air traffic control system, in a future society in which many drones fly in a airspace around the world, it will be essential to have a system to manage the drone operations. Additionally, collision avoidance technology will be absolutely necessary, and NEDO focuses on improving the environment for the purpose as well.

As for operation management, NEDO has developed a system consisting of operation management and integration functions, operation management function, and information service function, which it has begun using to support the safe operation of drones.

With regards to collision avoidance technology, NEDO will develop technologies to detect drones on the ground and other drones flying in the air, in order to instantly avoid collisions and continue flying.

Public awareness

Thinking about the life with robots from legal and insurance perspectives

In the process of new technology’s dissemination through society, it needs to earn understanding of local communities and citizens before being accepted by them. NEDO held a mock trial entitled “Can we judge the negligence by robots under the law?” at the International Robot Exhibition 2015 (IRED 2015), as part of NEDO’s effort to have local stakeholders recognize how the dissemination of robots and drones is related to their lives. It is also necessary to develop and structure an insurance plan to deal with the risk of accidents involving robots. At the NEDO Robot-Us Forum in 2016, an expert from an insurance company gave lecture highlighting the current situation and issues, by presenting several specific cases to show what kind of liabilities might occur if accidents were to happen with running-care robots.

There is a plan to conduct another mock trial in 2017, focusing on the environment of robots and drones in the future society.

Making further improvements to manufacturing by small and medium-sized businesses Realizing a “Platform Robot”

Transforming/ Manufacturing

Transforming/ Services

A robot recognizes the deformation state of a soft object and works accordingly. It is expected to expand the utilization of human and robot collaboration in future societies.

Transforming/ Infrastructure

Making it possible for workers to be more effective and activities to be more productive

Robots take background roles in the service industry

Recognizing clothes with image recognition technology and folding them with robot arms

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Transforming/ Manufacturing

Transforming/ Services

A robot recognizes the deformation state of a soft object and works accordingly. It is expected to expand the utilization of human and robot collaboration in future societies.
Realizing a Society Where Human and Robots Coexist and Cooperate

Hosting the World Robot Summit

In 2020, the same year as the Tokyo Olympics and Paralympics, the World Robot Summit (WRS), a competition and exhibition of excellence in robotics from around the world, will be hosted in Japan. (There will be a pre-summit in 2018.) As one of the efforts for the robots’ social implementation, NEDO and the Ministry of Economy, Trade and Industry (METI) have been working on the preparation.

Convening robotics experts from around the world

The World Robot Summit (WRS) is a competition and exhibition for excellence in robotics for attendees from around the world. NEDO aims to realize a world in which human and robots co-exist and cooperate, and to achieve this by accelerating the research and development in robotics as well as encouraging the social implementation of robots in everyday life, society and industry through competitions and exhibitions.

The robot competition will be called the World Robot Challenge (WRC), which asks competitors to design solutions for real-world situations that robots can play active roles in, including a competition set in the stores for the first time in the world, and an emergency response scenario for activities taking place in tunnels after disasters (see p.11 for the competition categories). The robot exhibitions will be called the World Robot Expo (WRE), which has exhibitions of advanced robots and robotics technologies implemented inside the competition venue, along with regional exhibitions that offer examples of advanced robotics being implemented in the society.

Providing opportunities to discuss and suggest future visions for humans and robots

NEDO aims to provide opportunities to recognize how daily life, industry, and society can be changed by robots by bringing awareness, interest, and understanding of robots to people, as well as by promoting research and development among scientists and engineers via close coordination with these competitions and exhibitions. NEDO, co-hosting the WRS with METI, has assumed the role of secretariat. “As one of the biggest events hosted by Japan, NEDO would like to have many people involved in addition to robotics experts from around the world, so we can provide the opportunity to discuss the future visions of how humans and robots could coexist and give suggestions on the direction of developments to the world,” said one of the secretariat members, Daishu Hara, Director of NEDO’s Robot and Artificial Intelligence Technology Department. Added Mari Inoue, Chief Officer of NEDO’s Robot and Artificial Intelligence Technology Department, “WRS has a Junior Category as well. For successful social implementation of robotics, it is essential to have innovative ideas from the younger generation and creative technology advancement. I’m already excited about seeing new kinds of robots I’ve never seen before.”

The first step for the successful WRS is to have a lot of competitors and participants get together. “The WRS logo is designed with a motif of robots, and it has been received well, as it gives an approachable feeling,” said Kouko Kotsuka, Chief Officer of NEDO’s Public Relations Department. “We present a wide variety of information and videos to introduce WRS on our special website. I hope many people will be interested in this summit, both domestically and internationally.”

The message of the WRS is “Robotics for Happiness.” The overarching goal is humans co-existing with robots and experiencing unprecedented prosperity. At NEDO, we look forward to the new technologies that we can bring our dreams upon, and the amazing innovations that create a positive future for everyone.

We’ll provide the opportunities for people to suggest future visions of how humans and robots can coexist to the world!

Mari Inoue
Chief Officer, Robot and Artificial Intelligence Technology Department, NEDO

I look forward to seeing the completely new robots created by the younger generation that is in charge of the future.

Kouko Kotsuka
Chief Officer, Public Relations Department, NEDO

I would like people to access the WRS special website and pay close attention to the wide variety of information and videos available there.

World Robot Summit 2018
Tokyo October 17-21

Name: World Robot Summit 2018 (pre-event)
Venue: Tokyo Big Sight East Halls 7 & 8

Held alongside:
Japan Robot Week 2018

World Robot Summit 2020
Aichi & Fukushima August & October (scheduled)

Name: World Robot Summit 2020 (main event)
Venue: Aichi International Exhibition Center

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AI That Can Enrich Human Life

In recent times, the research and development of artificial intelligence (AI) has advanced rapidly. In Japan, AI research and development is a national effort; to this end, the government has established the Artificial Intelligence Technology Strategy Council. Along with NEDO’s projects, this article will highlight how life and society will be enriched by AI technology as it continues to evolve.

Organizing the development stages of AI by phase

The “Research and Development Goals and Industrialization Roadmap for AI” sets the research and development goals for three fields: “Productivity,” “Health, Medical Care, and Welfare,” and “Mobility.” It also divides development stages into three phases. This shows that we are currently in Phase 1 and will make a transition to Phase 2 around 2020, then move to the Phase 3 sometime between 2025 and 2030.

Phase 1

- Increasing integration and efficiency of manufacturing, distribution, and services through IoT and AI
- AI utilized in all medical examinations and surgical procedures, and widespread home healthcare and medical care
- Utilizing travel time and space for work or hobbies with fully autonomous cars

Phase 2

- Establishing the “ultimate ecosystem” (a zero-waste society) by connecting various resources and services to IoT/AI
- Performing daily preventive healthcare using wearable sensors which all citizens wear, and becoming an industrialized nation with the world’s top level of health and longevity through advanced regenerative medicine
- Advancing the peripheral industries, including automatic update services for mobile equipment, as utilization of cyber and physical spaces expands and travel itself becomes a high-value-added commodity

Phase 3

- Urban and social transportation will be optimized by analyzing real-time sensing data installed in mobile devices and facilities. The dissemination of the automated driving will allow people to utilize traveling time for whatever purpose they choose.
- An ecosystem will be built by connecting multiple domains

A system of AI portals

NEDO has established an “AI Portal” where it has gathered and highlighted various information, including the research and development efforts for the “next-generation AI” collaboratively promoted by relevant agencies and organizations, as well as other related information.

Sharing a vision for the research, development, and industrialization of AI

AI has recently gained more attention in mainstream society after beating top professionals in matches of chess, shogi, and go. In 2016, the Ministry of Internal Affairs and Communications (MIC); the Ministry of Education, Culture, Sports, Science and Technology (MEXT); and the Ministry of Economy, and Trade and Industry (METI) cooperatively established the Artificial Intelligence Technology Strategy Council so industry, academia, and government organizations can work together for the purposes of not only improving the capabilities of AI, but also discussing how to utilize AI in society. In this council, NEDO is serving as a secretariat for various task force teams at the Industrial Cooperation Meeting which in charge of AI research and development as well as industry collaboration. Based on the experiences during the development of the “Vision for Prospective Artificial Intelligence (AI) Technologies and Applications” – the exit strategy for industrial AI formulated by METI and NEDO in April 2016 – the Industrial Cooperation Meeting has been assisting with the development of the “Research and Development Goals and Industrialization Roadmap for AI.”

To catch up with Europe and the US, which have more prominent presence in AI research, Japan’s strategy is to position AI as a key technology that can solve issues faced by society and enrich people’s lives, and to promote the research and development necessary to fully utilize this technology.

Promoting AI research and development that take advantage of Japan’s strengths

“NEDO’s basic principle is to research and develop AI that will be necessary for the future society we have as a goal – not based on existing particular technologies,” explained Koji Kanayama, Director of NEDO’s Robot and Artificial Intelligence Technology Department, adding, “in addition, we need to take advantage of Japan’s strengths to lead the world in the field of AI.”

AI has a statistical aspect, and the technology needs data in order to complete the learning. Japan, a world leader in industrial robotics, has a significant amount of accumulated data in this domain and is expected to utilize AI in manufacturing before any other applications. However, just possessing data does not necessarily guarantee success. For example, if we wish to use AI for communication, multiple sources of data, such as facial expressions, movements, and human voice recognition, will be necessary to achieve success.

Technological progress with AI is progressing exceptionally fast, so the roadmap will need to be periodically reviewed. Through its projects, NEDO plans to illustrate a future in which our working style will be changed and our lives and societies will be transformed through the use of AI, just as horse-drawn carriages have changed into cars.
It Can Happen!
AI for something

Thanks to past basic research and advanced technology research and development, sophisticated AI technologies have been developed in rapid succession. While accelerating the rate of social implementation of this technology as the next step, NEDO has been promoting even more advanced technology innovations. NEDO aims to help realize a more prosperous society from advances in “mobility,” “manufacturing,” “services,” and “health and medical care,” the domains further subdivided from the Industrialization Roadmap for AI.

NEDO has been working on its Development of Core Technology for Next-Generation AI and Robots project since FY2015. This project has two pillars: a next-generation artificial intelligence technology area, and an innovative robotics element technology area. By promoting the technology development of both AI technology, which is comparable to a human brain, and robotics technology, which can assist in moving objects, NEDO aims to create demand for the introduction of AI and robotics into new and unexpected fields that were never previously considered.

“Japan is a ‘follower’ in the AI domain,” said Hiromi Sekine, Director of NEDO’s Robot and Artificial Intelligence Technology Department, who is also a Project Manager of this project. “If we rely only on traditional and conventional ways of thinking, we won’t win against the world. Therefore, it’s very important to promote innovative, ‘out-of-the-box’ element technology development when integrating AI and robotics into society.”

As the first step towards realizing this goal, NEDO has worked to establish hubs where universities and businesses can synergistically utilize their knowledge and expertise in AI research. “The importance of AI has been dramatically increased as the key technology to realize AI in the areas such as image recognition and natural language understanding,” said Shun Ishikura, Chief Officer of NEDO’s Robot and Artificial Intelligence Technology Department. “Therefore, NEDO has established research and development hubs where we can combine the fragmented knowledge of different AI researchers, who have conducted research individually, and started to develop element technology to create innovative AI, instead of just relying on traditional and conventional ways of thinking. NEDO also modularizes these technologies to be suitable for each area.”

In other words, NEDO’s philosophy is not “technology first,” but rather to use technology as an advanced and powerful tool to solve issues in society. “AI utilization is meaningful when it realizes a society that enriches people’s lives, not just to strengthen industrial technology.” Mr. Sekine said as he reaffirmed the goals of the project. Under this project structure, NEDO aims to establish a platform to create a virtuous cycle of basic research and commercialization in AI, aiming to make real a future society that improves people’s lives.

Real-time analysis of surrounding conditions by AI

Due to the dissemination of satellites, satellite images are available at low cost, which has added significant value to the data they provide and has led to the development of businesses that can provide this data. In a recent NEDO project, technology was developed to detect buildings in surrounding areas based on the large amount of image data sent via satellite. By using machine learning and deep learning technologies, this technology can be used to analyze and visualize this image data to detect facilities on the ground. By doing so, it is possible to not only identify certain facilities such as "mega-solar plants" but also detect changes happening on the ground. This technology could help to provide smooth travel to destinations.

Realizing small-scale production of multiple items and accident prevention at production sites using AI

A robot looks at how a person moves the box up and down, and mimics the movement.

Robots that can mimic human movement through machine learning

In the manufacturing industry, it is expected that small-scale production of multiple items will soon become more important than traditional mass production methods. To realize this shift, industrial robots will need to be able to deal with situations autonomously and flexibly, instead of performing a single movement repeatedly as in the previous method.

NEDO has been working on AI research and development to realize a robot that can learn the relationship between visual information received from the on-board cameras and the movement of humans, and mimic it so it can autonomously make its own movements. Through this technology, robots have been able to fold soft objects and pick up previously unlearned objects, which was difficult to teach them in the past. Now, we are approaching the level where we will be able to mimic “broad moving natural robots” in the near future.

Aiming to improve quality in the service industry and create new services AI for Services

Using AI to analyze experiences, knowledge and information

Unlike the “product-oriented” manufacturing industry, the service industry is a “situation-oriented” field. In order to create higher quality services, it is necessary to collect and analyze “situations,” such as experiences, knowledge, and awareness of people in the service industry, and improve and restructure the operation based on this analysis.

NEDO has been collecting data of people’s experiences, knowledge, and awareness in the course of operations. By using the “Life Phenomena Modeling” AI analysis system, NEDO aims to streamline operations, improve the quality of services, and create new opportunities for the service industry. Even in the highly situation-dependent elder care industry, NEDO has been supporting the structuring of operation knowledge by improved compatibility with AI through standardized terms and actions on site.

Contributing to extend healthy life expectancies for a super-aged society with AI

Basic research in the medical field places importance on gaining knowledge from previously published academic literature, including scientific papers. However, it is difficult to find the necessary knowledge within the huge amount of the science and technology literature provided from researchers around the world, and current database building and maintenance capacity are not sufficient to this task.

To solve these problems, NEDO has been working to increase the research and development of a system to extract information about life system events, such as enzyme reactions and protein interactions, from the enormous literature base by using a superior text-mining system. This system, which enables the rapid construction of high-quality databases for enzyme reactions and signaling pathways in the cells, serves as a literature creation

Curating life science papers with AI

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A robot looks at how a person moves the box up and down, and mimics the movement.
News Release

NEDO Project Succeeds at World’s First 3D Imaging of Living Tissue with a Rigid Endoscope

A potassium tantalate niobate (KTN) crystal is a material that possesses a special electro-optic effect, in which the refractive index changes according to voltage levels. KTN has shown the maximum capability of this effect among existing materials. Because of this effect, optical deflection (scanning) can be realized with just one-hundredth of the voltage required by conventional material. By using this material in an optical scanner (a device that deflects laser beams), this device can operate with a significantly higher speed, smaller size, and lower power consumption level compared to conventional scanners.

NEDO, in cooperation with NTT Advanced Technology Corporation and Osaka University, under the “Clean Device Social Implementation Promotion Project,” incorporated an optical scanner using a KTN crystal (KTN optical scanner) inside a rigid endoscope. To achieve the size required for the rigid endoscope, which is palm-sized, it was essential to have superior electro-optic characteristics such as those in the KTN crystal. Therefore, this application was made possible only by using KTN crystals. By using this rigid endoscope in combination with the Optical Coherence Tomography (OCT), NEDO has succeeded in achieving the world’s first 3D imaging of living tissue. By using this method, it has enabled doctors to give real-time and minimally invasive diagnoses and treatments, just by making a tiny hole on the surface of the body to observe images of living tissues.

The number of endoscopic surgeries operated in Japan has already surpassed 170,000 cases. The 3D imaging rigid endoscope developed in this project can be deployed for both conventional endoscopic surgeries and robotic surgeries, and it is expected to be used in a wide range of applications in the medical field. NTT Advanced Technology Corporation is aiming to deploy the endoscopes broadly across medical fields that utilize endoscopic surgery techniques, including orthopedics, and to start providing them to medical device makers as a new type of technology. April 14, 2017 News Release http://www.nedo.go.jp/english/news/AA5en_100215.html

Glossary

KTN (potassium tantalate niobate) Electro-optic crystal with the chemical formula of KTa1-xNbxO3. It characteristically shows transparency and large electro-optic effect in a wide range of wavelengths.

Electro-optic effect The phenomenon in which the refractive index is changed with the applied voltage. There are two major electro-optic effects: the Pockels effect, in which the refractive index is proportional to the voltage, and the Kerr effect, in which the refractive index is proportional to the square of the voltage. KTN shows both.

Rigid endoscope One of the devices used for endoscopic surgeries and diagnoses, called a videoscope. A CCD camera and light guide are incorporated at the tip of a metal tube that measures 15 mm in diameter, and the physician studies the affected area with CCD, using the light guide to illuminate the area. During surgery, this metal tube is inserted into the affected area through a tiny hole in the body, and the surgeon does the operation while studying the image of the area.

Optical Coherence Tomography (OCT) Technology which visualizes structures along to the depth direction with a high-resolution and a high-speed by exploiting the optical coherence. This non-invasive tomographic technology has no risk of radiation exposure because it uses a laser beam to capture images. Recently, it has been widely adopted for use in clinical practice, especially in ophthalmology and cardiovascular internal medicine.

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The results of NEDO projects are utilized in manufacturing processes used by companies and final products available for consumers. In this series, we look at untold stories of how technology development projects scaled the high, difficult wall to successful commercialization and what came after, summarizing past articles in "NEDO Project Success Stories."

Strategic Development of Energy Conservation Technology Project

Air cycle refrigeration system: using “air” as the refrigerant for minus 60°C ultralow temperature storage

What is the “Strategic Development of Energy Conservation Technology Project”? Japan has been making national efforts toward energy conservation since an oil crisis in the 1970s. In addition, since the 1980s, global warming has been discussed as a global issue. To achieve the goal stated in its “New National Energy Strategy” (released in May 2006), NEDO openly solicited ideas for energy conservation technology research and development, and strategically conducted research and development projects including basic research, development of practical applications, and demonstration studies.

Industrial refrigeration equipment producer Mayekawa Mfg. Co., Ltd. took on the challenge of developing an innovative system using air as a refrigerant instead of conventional chlorofluorocarbons. This air-cycle system is for use in “ultralow temperature storage” systems for tuna and other fish. Through this project, in collaboration with the cold storage industry as users, Mayekawa established a new technology that uses air as a safe and innovative refrigerant, and which has high energy conservation capabilities that could reduce annual electricity consumption by up to 50%.

An air refrigeration system friendly to both tuna and the environment, providing a solution to the “fluorocarbon refrigerant issue”

Ultralow temperature refrigeration technology, reaching temperatures as low as minus 60°C, is essential for the safe storage of fish, including tuna and bonito. However, the majority of large ultralow temperature storage solutions were built in the 1960s. At that time, chlorofluorocarbons (HFC22: hydrochlorofluorocarbon 22) were commonly used as the refrigerant, but they are now designated a controlled substance under the Montreal Protocol because they deplete the ozone layer. HFC22 has been prohibited for use in new facilities since 2010. Although manufacturers are still allowed to produce HFC22 to replace existing refrigeration units, the Montreal Protocol requires total abatement of production of HFC22 by 2020.

Mayekawa was searching for a solution to this problem. They came up with the idea of “using air as a refrigerant.” From FY2003 to FY2005, they conducted practical application development through a NEDO project, "Development of Dethihalogenation-type High Performance Air-based Refrigeration System That Uses Polymer Adsortent." They took on the challenge of developing an innovative system using air as the refrigerant instead of conventional chlorofluorocarbons.

An all-in-one compressor/expander: the heart of Pascal Air

The "Pascal Air" refrigeration system utilizes a simple phenomenon: gas produces heat when it is compressed and releases heat when it is expanded. In the Pascal Air system, air from the storage room is sent to the compressor. Compressed air from the compressor goes to the "primary heat exchanger" where it is cooled. Air is further cooled through the heat exchanger with cold air from the storage room before it goes to the expander where it is expanded to low temperatures. By repeating these steps, the temperature inside the system can be lowered. In the conventional systems, "air coolers" use air as refrigerants (such as HFC22). The Pascal Air refrigeration system has no "air coolers" because the air in the storage room circulates inside Pascal Air as the refrigerant, cooling the room. This enables efficient refrigeration because it significantly reduces the energy required to cool the room, in addition to eliminating energy loss during heat exchange.

Development of the "all-in-one turbo compressor and expander" which integrated the compressor and expander into one unit, is what has enabled this simple and highly energy-efficient freezing cycle. As air is expanded in the turbine, the rotating torque of the impellers assists rotation of the motor, thus reducing the required power. The most distinguishing feature is that the compressor and expander are connected via a shaft, which includes the motor. Due to this innovative mechanism, it is possible to reduce the power needed for the motor to just 60 kW, about two-thirds of the amount needed for the motor on its own (90 kW). The effects of temperature difference in “all-in-one compressor and turbo expander” were one of the major points considered in the structural design and material fabrication of the Pascal Air. While the temperature of the compressor and motor can get as high as 90°C or above, the temperature of the expander side is as low as minus 80°C, and the difference could therefore be more than 200°C between the two sides. What’s more, by adopting a magnetic bearing, which keeps the rotating shaft floating, the system avoids wearing out any parts, resulting in a maintenance-free system.

To remove moisture that develops during storage, Mayekawa developed a system in collaboration with Okayama University to dehumidify the storage room using polymer materials to absorb moisture in the circulating air. However, they recognized costs would be too high if polymers were used, so in the second half of the project, they looked at the system from a different angle. They came up with the “frost trap,” a mechanism which freezes moisture and traps it before it reaches a point where ice can cause problems in the system.

Reaffirming the system’s various merits in addition to its environmental performance

Cold storage companies, the users of the system, also supported practical application development. Field tests were conducted at an old warehouse belonging to Fukazawa Cold Storage Co., Inc. in Yazeri, Shiinakawa Prefecture, an area well-known as the main landing site for tuna.

As Fukazawa used the system in practice, they found out that it exceeded their expectations. They found a large number of benefits in using it to operate the warehouse in addition to maintaining the quality of tuna stored there. The system eliminated the need to purchase the chlorofluorocarbon refrigerant, refrigerant oil, and antifreeze necessary to replenish in the conventional system. The system also reduced electricity bills by 45%, because the new system can efficiently cool the storage space with a small amount of air flow while maintaining an even temperature.

With the conventional system, it was necessary to spend time and money to remove the thick frost that covered the air cooler, but with this system, almost no cost is expended on defrosting. In addition, it is not necessary to install an air cooler, which increases the amount of space available in the storage room, which in turn enables the storage of a greater amount of tuna.

Operational benefits and energy conservation Expanding applications

Using air to cool cold storage rooms alone has a significant impact and improves performance from an environmental perspective. However, this system provides solutions for many other issues caused by conventional ultralow temperature refrigeration. The cooling load is reduced to two-thirds of the conventional system because of elimination of air coolers and defrosting, and the energy consumption of the whole system is reduced by up to 50%.

The High Pressure Gas Act is not applicable to this system because the system is operated at pressures near atmospheric pressure (under 0.2 MPa), which removes major burdens on facility operators, including submitting various papers at the time of facility’s construction and placing a security supervisor on duty at all times.

In December 2008, about five and a half years after research and development began, Pascal Air (refrigeration capacity of 30 kW) went on the market for the first time. As of 2017, eighty-one systems have been delivered to the ultralow temperature storage facilities around the country, supporting the steady supply of tuna to consumers through the tuna cold storage market.

Even though the Pascal Air system was initially used in the tuna cold storage market, twelve of the Pascal Air system have been delivered to facilities serving the frozen food, pharmaceutical, and chemical fields. This significantly broadens the system’s applications, and new markets are expected to further develop, including high-temperature superconductor cooling, semiconductor cooling, medical material storage (serums, specimens, DNA, etc.), and freeze-fracturing.

In “NEDO Project Success Stories,” we interview the developers including corporations involved in the project and post success stories on the website. http://www.nedo.go.jp/content/100799089.pdf
第44回国際福祉機器展
27~29日
NEDOフォーラム in 兵庫
26日
“エ キ シ ビ シ ョ ン ”
日印エネルギーフォーラム2017
20~22日
NEDO新エネルギー成果報告会
19~22日
科学とあそぶ幸せな一日
1日
5~6 日
CALENDAR
NEDOのイベントスケジュール
2017年
イ ノ プロム2017
10~13日
StartupThailand
6~9日
第12回再生可能エネルギー
5~7日
環境部事業報告会
26~27日
Thailand Industry Expo 2017
25~30日
セミナー (第1回)
14日
NEDOフォーラム in 熊本
21日
NEDOフォーラム in 三重
8日
創エネ ・ あかりパーク2017
1~5日
「次世代人工知能 ・ ロボッ ト Innovation for Cool Earth
4~5日
CEATEC 2017
3~6日
Conference & Expo(AEECE)
Asia Energy Efficiency
30日~11月2 日
NEDOフォーラム in 長野
27日
BioJapan2017
11~13日
NEDOフォーラム in 山形
6日
(ビジネスマッチングイベン ト)
中核技術開発」 ワークショ ップ
1日