NEDO

focus NEDO

2022
No.86

Reporting on Today and Tomorrow's Energy, Environmental and Industrial Technologies

Special Report

Innovative AI Technologies at Work in the Real World

AI Edge Computing

New Energy and Industrial Technology Development Organization

Improving the environment through purification of nitrogen oxides contained in exhaust gas!

New Composition Tuning Method for Small Pore Zeolites Improves Durability of Automotive Exhaust Catalysts

To realize carbon neutrality, engines using synthetic fuels (e-fuels) made from carbon dioxide or biomass are expected to become increasingly popular. A problem with using these fuels, however, has been that their exhaust gases contain harmful nitrogen oxides that can result in acid rain and cause disruptions of the nitrogen cycle. Diesel engines used in buses and trucks, in particular, emit elevated levels of nitrogen oxides, so there is an urgent need to reduce such emissions. The dilemma in this situation is that as engine fuel efficiency improves, nitrogen oxide emissions also increase, thereby making it inevitable that more advanced technologies for the treatment of exhaust gases will become necessary.

Small pore zeolites are attracting attention as catalysts that can convert the nitrogen oxides contained in exhaust gases into harmless nitrogen. Durability has been an issue, however, since catalysts for automotive exhaust gas are used throughout a car's life span.

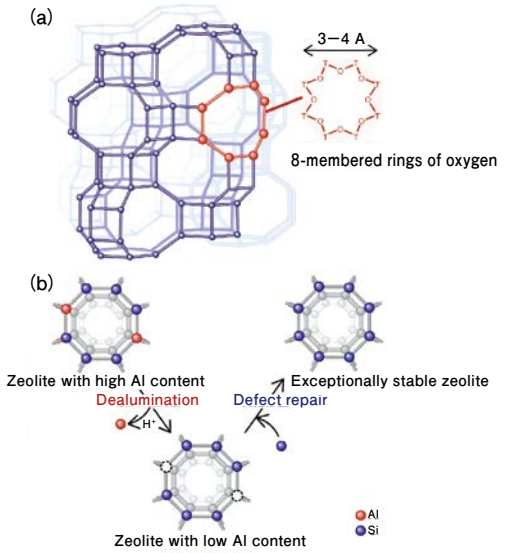
In this context, a research group from the University of Tokyo has been developing a new composition tuning method for small pore zeolites under the NEDO Moonshot Research and Development Program. Issues to be addressed include the difficulty for substances to enter and leave due to the small pore size of conventional small pore zeolites and the fact that their framework structure collapses when tuning composition is forcibly carried out. In this research, a new method has been developed to prevent the collapse of the structure by allowing material to move through expanding pores, resulting in a new type of zeolite with improved composition and superior durability.

In addition to its application to catalysts for automotive exhaust gases, the outcome of this research is expected to be used to address environmental problems related to nitrogen oxides for other materials. Together with the University of Tokyo, NEDO intends to develop new applications based on the results of this project and implement them in society.

MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

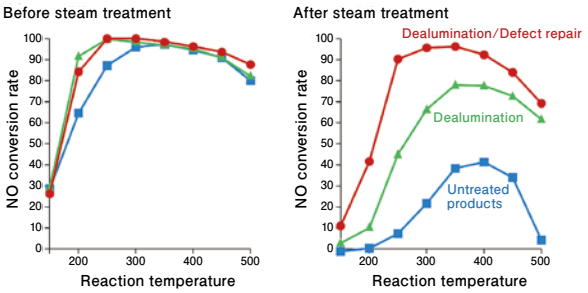
The Moonshot Research and Development Program, coordinated by the Cabinet Office of Japan, was established to promote ambitious research and development based on bold ideas that are not just extensions of conventional technologies, with the aim of stimulating disruptive innovation in Japan.
As a research promotion organization engaged in the Moonshot Research and Development program and taking into account the Moonshot Goals determined by the Cabinet Office's Council for Science, Technology and Innovation and the R&D concepts formulated by the Ministry of Economy, Trade and Industry, NEDO is pursuing ambitious R&D activities to achieve Moonshot Goal 4: Realization of sustainable resource circulation to recover the global environment by 2050.

Schematic diagram of small pore zeolite composition tuning method



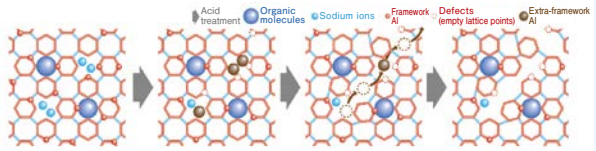
Exceptionally stable zeolite that retains its framework structure is realized by removing aluminum (Al) while organic matter remains in the zeolite pores and combining it with defect repair technology.

Results of catalyst testing



Zeolites with structural defects repaired after Al removal showed elevated levels of activity and hydrothermal stability after 7 hours of treatment with 800°C steam.

Mechanism of pore expansion and migration process



Extra-framework Al detached from zeolite is large and therefore cannot normally pass through small pore zeolite but can do so when pores are partially broken, and pore diameter is widened.

NEDO news release on this research:

https://www.nedo.go.jp/news/press/AA5_101547.html

Only available in Japanese

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CONTENTS

Reporting on Today and Tomorrow's Energy, Environmental, and Industrial Technologies

"Focus NEDO" is the public relations magazine of the New Energy and Industry Technology Development Organization (NEDO), introducing the public to NEDO's various projects and technology development activities related to energy, environmental, and industrial technologies.

Note: To prevent the spread of COVID-19, persons appearing in photos wore facial coverings except during the time photos were taken.

Editor's Voice — A Few Words from the Editor

The focus for this issue is AI edge computing. AI currently requires huge volumes of data exchange because its "learning" and "inference" functions are performed by cloud-based servers. When decisions need to be made at a moment's notice, it is not possible to wait for AI to make a decision, so AI edge computing is considered one way to address this issue. To show how AI will be used in the future, we introduce several ongoing NEDO projects that are developing technologies for new types of processors, autonomous driving, and drone systems.

Special Report

Innovative AI Technologies at Work in the Real World

AI Edge Computing

A full-fledged IoT world is one overflowing with vast amounts of data. NEDO is developing innovative AI edge computing technologies to address issues such as increasing levels of energy consumption.

Strengthening the competitiveness of Japan's IT industry to capture future market opportunities

AI is beginning to be used in a wide range of sectors, such as manufacturing, healthcare, logistics/transportation, and agriculture. Current AI operations assume that "learning" and "inference" functions are carried out by cloud-based servers. In today's world, both the volume of data and the energy used to process it are increasing rapidly.

In addition, the distance between worksites and servers makes real-time responses difficult and, if communications become unstable, fully autonomous vehicles and service robots could become involved in serious accidents.

One way to address these challenges is through AI edge computing. Because inference functions are performed at the edge (i.e., near users) using AI learning models, not only are real-time responses possible, but data can also be processed without constant connection to the internet. AI edge computing also sends data to cloud servers for learning purposes, but only specific data is sent, which helps ensure security and reduces costs for communications.

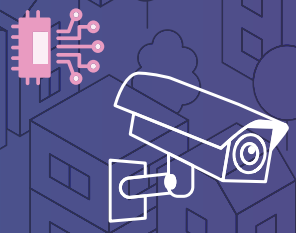
As we enter the so-called post-Moore era* and game-changing events are expected on a global scale, NEDO is working to develop innovative AI edge computing technologies that leverage Japan's strengths.

The technological challenge is how to realize high-speed processing capability with low levels of power consumption and develop innovative technologies that are not mere extensions of conventional technologies, such as innovative AI chips that enable information processing at edge locations and integrated technologies for both hardware and software.

Japan possesses globally competitive technologies in the areas of energy conservation and embedded technologies, which are indispensable for edge computing. NEDO aims to therefore combine Japan's current areas of strength with the innovative ideas and flexible approaches possessed by small and medium-sized startups, realize commercialization as quickly as possible, and thereby contribute to the resolution of social issues as well as strengthen the competitiveness of Japan's IT sector.

In the following pages, we interview NEDO project leaders and introduce examples of how they overcame high hurdles to realize innovative technologies for AI edge computing, including AI systems that have the capability to learn at edge locations, fully autonomous self-driving cars, autonomously controlled drones, and software stacks for embedded IT systems.

※Post-Moore Era
This term refers to the era in which Moore's law, which stipulates that semiconductor performance doubles every 18 months, is expected to reach its physical limit during the 2020s, and ongoing efforts to realize the next generation of semiconductor technologies.

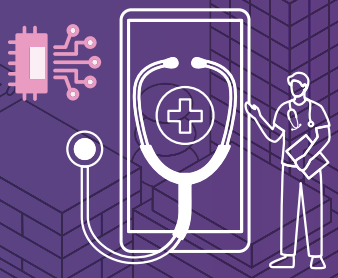


Community monitoring/ infrastructure management

Support for neighborhood watch organizations to realize safe communities

Infrastructure inspections/ crowd control

Automated inspections of physical infrastructure, relief efforts after natural disasters, security for large events

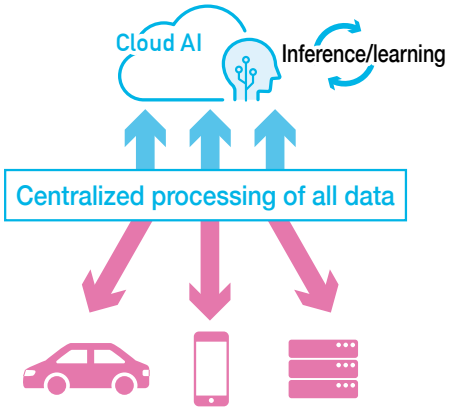


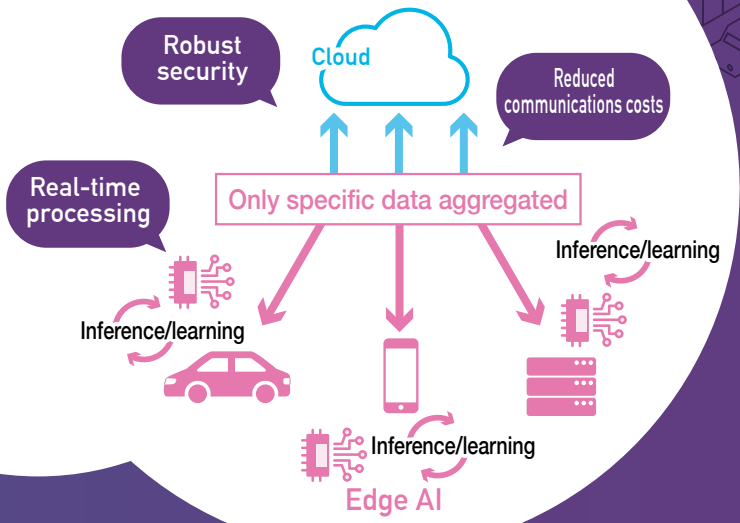
Healthcare

Rapid/accurate diagnoses, assistance during surgeries, support for telemedicine

From the cloud to the edge

Example of AI use to date ---------- Example of AI edge computing



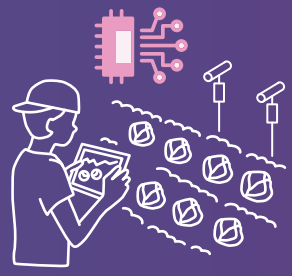


Autonomous driving

Realization of ubiquitous transportation and logistics services

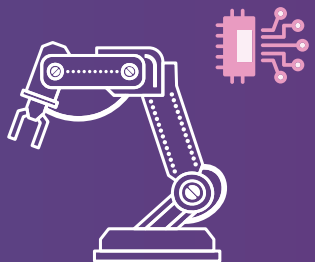
Distribution

Product development, store operations, implementation of marketing initiatives



Agriculture

Reduction of crop risks, improvement of profitability/revenue



Manufacturing

Predictive maintenance of machinery/equipment, enhanced worker safety

PROJECT LEADER INTERVIEW

Project Leader of NEDO's Project for Innovative AI Chip and Next-Generation Computing Technology Development/ Development of Innovative AI Edge Computing Technologies

MOTOMURA Masato

Professor Motomura holds a Ph.D. in engineering and works at the Tokyo Institute of Technology's Institute of Innovative Research. After receiving his master's degree from Kyoto University in 1987, he began working at NEC Corporation on R&D and commercialization of products such as reconfigurable hardware and on-chip multiprocessors. From 1991-92, he was a visiting researcher at the Massachusetts Institute of Technology in the United States. He became a professor at Hokkaido University in 2011 and assumed his current position at the Tokyo Institute of Technology in 2019. Dr. Motomura received the title of Fellow from the Institute of Electrical and Electronics Engineers (IEEE) in 2022 and, in the same year, was also awarded the Ichimura Prize in Science for Distinguished Achievement.

Fostering Japanese Technologies Through Diverse Range of Players Conducting Persistent Research

Thoughts of project leader

AI edge computing technologies are the object of intense global competition. In this interview, we ask project leader MOTOMURA Masato to share his views regarding the significance of this project, its accomplishments to date, and its prospects.

—Since 2018, NEDO has been promoting the development of AI edge computing technologies to address social issues in the so-called post-Moore era. Professor Motomura, could you tell us about your feelings at the time you were appointed as project leader?

This project addresses an area close to my own field of research, and at the time it started, the United States and China were already moving forward with R&D efforts at a rapid pace, so I felt it was necessary for Japan to focus more attention on development efforts. I therefore accepted the role as project leader in this NEDO project with the hope that my involvement would help energize the development of AI edge computing in Japan.

—As the project leader, what did you focus on?

AI edge computing is probably the most dynamic research field right now, with innovative ideas emerging every day. It is therefore essential to be aware of new developments in the field. For those research groups unfamiliar with the latest outcomes, we offered guidance from that perspective. To keep the project consistently moving forward, we also encouraged researchers to conduct R&D on hardware and software in a way that considers potential applications and use scenarios.

—How would you evaluate the progress of the project?

I believe each research group has more or less realized the goal of increasing the level of power efficiency by a factor of 10 or more. Despite the trial-and-error nature of the project, I think everyone has realized great outcomes. On the other hand, I believe it is also important to evaluate the project in terms that can't be expressed by numbers. In terms of fostering market-leading technologies, I think having an eye for recognizing value is as important as carrying out research and development. Some of the companies participating in the project already have a proven track record, while others were previously unknown, thereby giving us a sense of Japan's vitality in this field. It has also been encouraging to see the emergence of a new ecosystem when new public solicitations for proposals were issued after the start of the project. I believe a challenge for the future is connecting this trend to younger generations.

—What do you believe is the significance of this project?

Without this project, I believe the level of AI edge computing activities in Japan would remain low and continue to lag far behind the rest of the world. NEDO's continued support for R&D activities is by no means insignificant.

Technology dominant in today's market will not necessarily remain dominant 10 years from now. The speed of evolution is particularly fast in this field, and if we continue to challenge ourselves, there is a good chance a technology will emerge that will put us in the spotlight. To realize this, it is important to lay the groundwork for diverse players to emerge, nurture human resources, and continue persistent research efforts. I hope NEDO will continue to provide support so Japan can compete with the rest of the world by leveraging its strengths in embedded technology.

PROJECT. 1/4

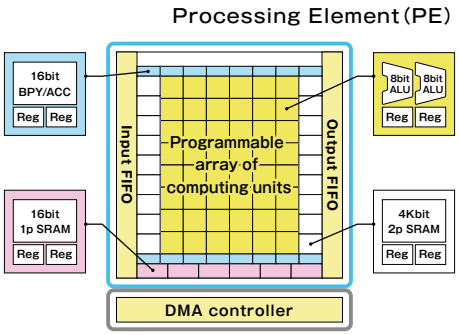
R&D of embedded AI systems using dynamic reconfiguration technologies

Development of DRP-AI Processor Realizing 10 Times Greater Power Efficiency and Capable of Making Autonomously Adjustments to Changes in On-site Environments and Task

On-chip learning system capable of performing inference and learning functions, and tools to make it easy to incorporate AI technologies into products that meet real user needs

DRP Dynamically Reconfigurable Processor

Simultaneous parallel operation of different processes



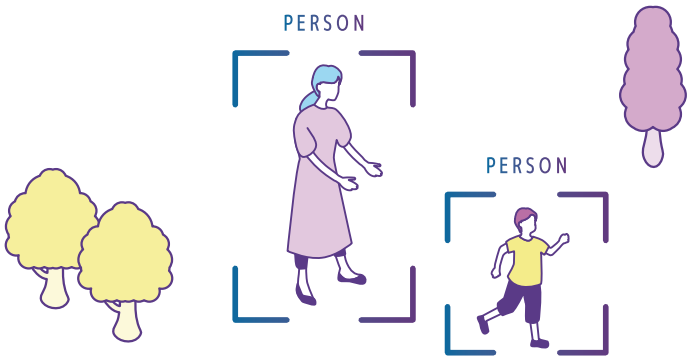
Addressing issues related to aging/shrinking workforce

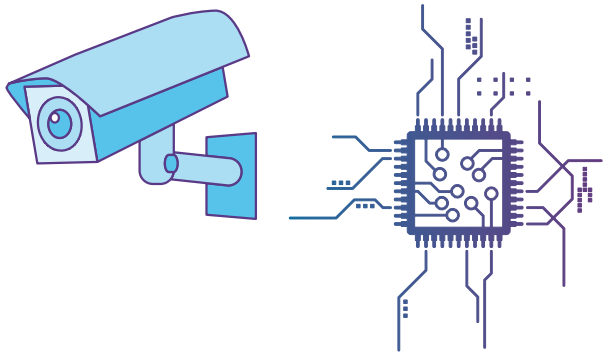
As workforce numbers decline due to falling birthrates and an aging population, embedded AI that processes data and responds in real time is needed at worksites in various locations and sectors, such as factories, service robots, logistics, and healthcare.

To address these needs, this NEDO project is developing architecture and design support tools for the social implementation of embedded AI systems that consume low levels of power using a Dynamically Reconfigurable Processor (DRP) capable of handling complex tasks. Four organizations have been collaborating on this project: Renesas Electronics Corporation, responsible for the development of hardware; Tokyo Institute of Technology, responsible for the development of advanced architecture; SOINN Inc., responsible for the development of machine-learning algorithms and the execution of demonstration testing; and Mitsubishi Electric Corporation, responsible for the development of light-weight AI software technology.

Development of DRP-AI processors with high performance/low power consumption and tools to facilitate easy AI integration

NOSE Koichi, Senior Principal Engineer, Product and Technology Management Department, Renesas Electronics Corporation, explains that two major challenges had to be overcome to realize embedded AI: “One challenge concerned processing complex tasks at high speeds, and the other was how to reduce the level of heat generated during processing.” (9-1) Based on its reconfigurable processor technology cultivated over many years, Renesas Electronics has been developing a DRP-AI





processor that combines high levels of AI processing performance and low levels of power consumption, as well as developing tools to facilitate the integration of AI into actual products.

TOI Takao, Senior Manager in Renesas Electronics Corporation's Product and Technology Development Department, recalls that achieving the target of 10 TOPS/W* was not so easy: "We initially thought of using low-bit quantization to reduce the amount of calculations. We proceeded to the prototype stage, but it turned out it was difficult to realize AI recognition accuracy with this quantization technology alone. When we decided to try using a method that increases the pruning rate of neural networks in combination with the quantization, however, we realized that this would work after making the second prototype chip. Based on this discovery, we were finally able to finish work on an AI chip we could really be satisfied with." NOSE also comments, "Trying to realize extremely ambitious goals was also a motivation for our development efforts. AI technology has evolved significantly over the past five years, and I believe we set the right goals." The DRP-AI processor developed by Renesas Electronics also exhibits flexibility, with the ability to learn in response to the environment in which it is placed.

BABA Mitsuo, Senior Director in Renesas Electronics Corporation's Enterprise Infrastructure Business Division, explains that "Market research has shown that in the case of visual inspections in the manufacturing industry, for example, the system must be able to respond to changing lighting and other conditions. The new DRP-AI processor can easily handle such situations."

Realizing ambitious targets is major impetus toward commercialization

NOSE describes the significance of the NEDO project, saying that "Challenging goals were achieved because multiple organizations worked together toward the same goals within the framework and support of NEDO." TOI agrees and notes further that "Lots of valuable advice from the experts on the project's technology promotion committee were also very helpful in the development of the project."

HIROSE Kenji, Project Coordinator in the NEDO Internet of Things Promotion Department, describes the magnitude of the project's achievements, saying, "The development of an embedded AI system is a project milestone," while IWASA Tadahiro, Chief Officer in the NEDO Internet of Things Promotion Department and Project Manager, says, "We expect the processor to gain a competitive advantage as a domestically produced semiconductor chip."

Realizing the target of 10 TOPS/W and developing tools that make it easy to incorporate AI technologies will serve as major appeal points for commercialization efforts and will also work positively in promoting social implementation.

BABA adds, "We plan to launch the product within the next year. The day is coming soon when DRP-AI processors, which can realize any specification with software, will drive the marketplace."

※Note: TOPS/W expresses power efficiency in terms of tera operations per second per watt of power consumption. Higher TOPS/W values indicate lower levels of power consumption when processing certain problems at certain speeds and thus represent higher levels of power efficiency.

BABA Mitsuo
Senior Director, Business Planning
Enterprise Infrastructure Business Division
IoT and Infrastructure Business Unit
Renesas Electronics Corporation

HIROSE Kenji
(left in photo)
Project Coordinator
NEDO Internet of Things Promotion Department

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Product and Technology Development Department Section2
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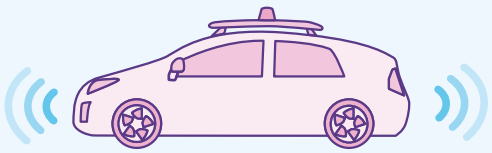
PROJECT. 2/4

R&D of system-on-chip and software platforms for fully autonomous driving



Taking Big Steps Toward Realizing Efficient and Safe Fully Autonomous Driving

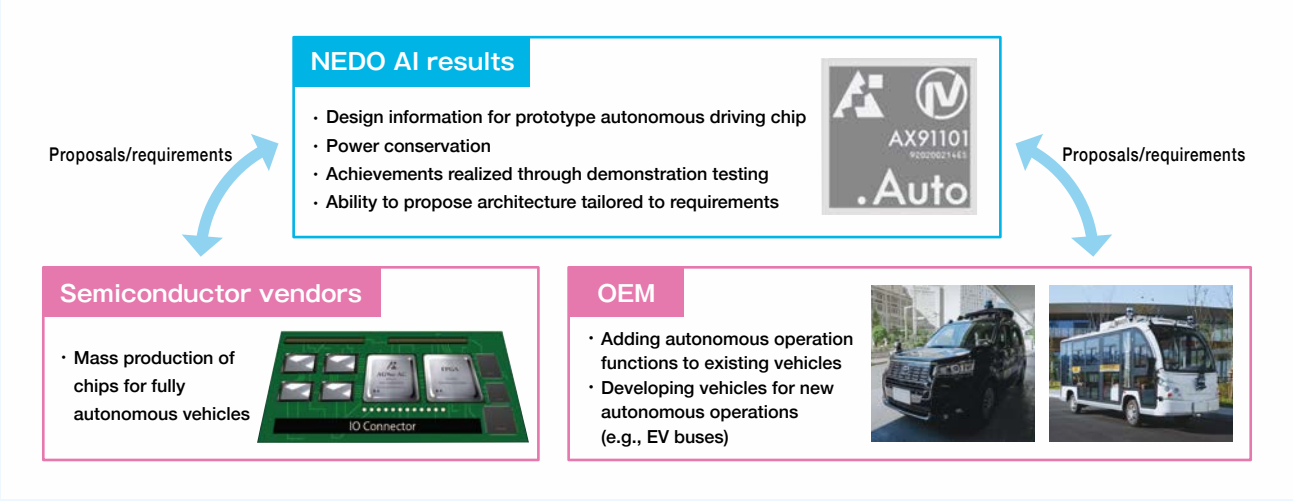
Development of integrated platform making effective use of limited computational resources to realize near-term commercialization of fully autonomous vehicles

Realizing fully autonomous vehicles beneficial to society

One example of AI edge computing is its use in fully autonomous vehicles. The realization of fully autonomous vehicles will bring numerous benefits to society, such as securing transportation for the elderly and physically disabled, maintaining logistics operations, eliminating traffic congestion, and reducing CO_2 levels through improved fuel efficiency. However, a significant reduction in the power consumption of AI chips is necessary to promote their widespread use. With the goal of addressing this issue, the NEDO project is promoting R&D on system-on-chip (SoC) and software platforms for fully autonomous driving.

The following four organizations are collaborating on R&D activities for this project: Axell Corporation, responsible for SoC development; the University of Tokyo, responsible for compiler/OS development; Saitama University, responsible for middleware development; and TIER IV Inc., responsible for the development of autonomous driving applications, the execution of road testing, and the development of higher performance accelerators.

In addition to an Autoware controlled system, this experimental vehicle is equipped with 14 LiDAR devices and cameras, a global navigation satellite system, and an inertial measurement unit.



Striving to stay at forefront of rapidly evolving autonomous driving field

HAMADA Takayuki of TIER IV's Engineering Division explains that "Currently, autonomous driving equipment takes up most of the vehicle' s trunk space, but if this project is able to establish an integrated platform for autonomous driving applications, it will bring us much closer to realizing fully autonomous driving without sacrificing trunk space." FUNAOKA Kenji, an architect in the TIER IV Engineering Division, describes positive results that will lead to commercialization by saying "One of the goals of this project is to show the world it is possible to realize standards for both power conservation and safety through collaborations between industry, academia, and government organizations. Building on this, we believe this work will also promote collaborations between automakers and semiconductor manufacturers."

MURAKAMI Daichi, also of TIER IV's Engineering Division, says, "In this project, we are seeing a shift from traditional hardware-centric development to software-defined development, where functionality is defined by software. The accelerator we developed has a unique structure with multiple functions in a single package, so we struggled to find the right balance when designing it. Although for the time being we have realized a solution to this issue, we expect that the combinations we are testing will change in the future." Regarding the rapid changes in technology in this field, Funaoka says "the technology related to autonomous driving is evolving at a dizzying pace so we are trying to keep up with the latest technologies and develop products that can be adapted to changes."

Moving from demonstration testing using more energy-efficient prototypes to realizing global standards

In December 2022, demonstration testing is planned for fully autonomous driving of market-ready vehicles equipped with more energy-efficient prototype equipment. Based on the data obtained during these tests, Tier IV plans to standardize performance levels for different autonomous driving applications, such as buses for urban areas, factories/warehouses, and airports, and propose these applications for use in global markets.

Commenting on the significance of the NEDO project, Funaoka says, "Without participating in this project, it would have been difficult to make the equipment more power efficient. We are grateful for the feedback we received from the experts on the project's technology promotion committee, which accelerated our development efforts on fully autonomous driving, a topic for which no one has all the answers." Hamada adds, "Through discussions with experts, I was also able to acquire the ability to better explain our work. Having this ability is also useful when explaining the results of this project." KUMASAWA Tadashi, a technical researcher in the NEDO Internet of Things Promotion Department, says, "We were able to share our awareness of the issues with experts, which certainly accelerated our technology development efforts."

Project Manager IWASA Tadahiro of NEDO's Internet of Things Promotion Department expresses his expectations for the future by saying, "Autonomous driving is a growing field and NEDO is supporting the growth of Japanese technology in this area so it can become globally competitive and lead to flourishing business opportunities."

KUMASAWA Tadashi
(second from left)
Technical Researcher
NEDO Internet of Things Promotion Department

IWASA Tadahiro
(second from right)
Chief Officer
NEDO Internet of Things Promotion Department

MURAKAMI Daiichi
(far left)
Engineering Division
TIER IV, Inc.

FUNAOKA Kenji
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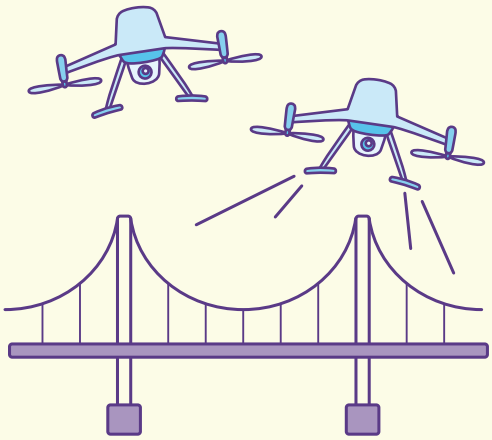
Engineering Division
TIER IV, Inc.

HAMADA Takayuki
(far right)
Engineering Division
TIER IV, Inc.



Smart drone equipped with advanced autonomous learning functions and autonomous flight control system

PROJECT. 3/4

R&D for AI edge computing technologies with advanced autonomous learning functions for 5G era

Using Autonomous Drones with Advanced Learning Functions to Expand Demand for Infrastructure Inspections and Other Services

Successful development of light-weight AI that can be mounted on drones through enhancement of algorithmic compression and autonomous learning functions.

Development of learning algorithm that compresses amount of data required for AI processing to one-tenth and realizes satisfactory object detection performance

Japan's amended Civil Aeronautics Act, which becomes effective as of December 2022, allows drones to be flown beyond the operator's visual line of sight in populated areas (Level 4), so demand for drones is expected to increase in a variety of fields, including logistics, inspections, security operations, and surveillance. For more advanced autonomous flight, it is essential to have technology that allows the processing device to analyze the vast amount of information collected by the cameras and sensors that serve as the eyes of the drone, make instantaneous decisions, and be linked to flight control. However, drones, which are subject to significant resource constraints related to weight and power, face the problem of reduced flight conditions when equipped with advanced AI processing devices.

Aiming to address these issues, KDDI Corporation and Araya Corporation submitted a proposal under NEDO's Development of Innovative AI Edge Computing Technology project that was selected for implementation. The two companies took on the challenge of carrying out R&D on the use of AI edge computing for the development of autonomous flight control technology, edge-cloud collaboration technology, and advanced autonomous learning functions.

The project aims to develop light-weight AI processing devices using data streamlining to reduce the amount of computation and at the same time develop "artificial consciousness" where the AI system learns by itself and makes autonomous decisions. The project confirmed that a drone equipped with multiple learning algorithms can detect objects using just one-tenth the amount of data. Based on these results, the possibility of applying this system to structural inspections will be studied.

SUGITA Hiroshi of KDDI says that "The multi-year NEDO project made it easy to plan development efforts and was a great tool for public outreach." HASUI Shigeki of Araya looks back and notes, "It was a great benefit being able to use our technology to conduct original R&D on specific issues." TAMAI Shinya of Araya shares his aspirations, saying, "We would like to realize technology that enables drones to learn more intelligently and autonomously through artificial consciousness and then use these drones in real world situations."

SUGITA Hiroshi
(left)
Leader, DX Planning & Development Department
Business Exploration & Development Division
KDDI Corporation

HASUI Shigeki
(center)
Chief Engineering Officer
New Business Development Department
Araya Inc.

TAMAI Shinya
(right)
Senior Engineer
New Business Development Department
Araya Inc.

PROJECT. 4/4

Design and development of compiler backend and supported runtime environment for secure open architecture

RISC-V

Promoting Use of RISC-V to Improve Competitiveness of Embedded Systems

Joint development of OS and development support tools for RISC-V cores that realize high levels of processing efficiency/real-time performance and provide competitive edge in marketplace

Promoting commercialization and domestic use of RISC-V by leveraging technological collaborations strengthened through joint research projects

In recent years, open-source RISC-V has shown rapid growth as an instruction set architecture (ISA) for embedded CPUs, replacing licensed proprietary architecture provided by Arm and other companies, which had previously held a large market share. However, there are still many issues to address in the development of an RISC-V environment, such as processing efficiency, real-time performance, safety, and power costs.

Against this background, NEDO, in collaboration with eSOL Co. Ltd., Kyoto Microcomputer Co. Ltd., NSITEXE Inc., and OTSL Inc., undertook R&D on a tool chain including a software stack for easy-to-use embedded systems, with the aim of improving the development environment and practical application of OS and applications based on the RISC-V core.

The project includes the development of an RISC-V-optimized, multi-core-capable, high-performance runtime environment (RTE/OS), a C code compiler, and parallelization support tools for RISC-V. As part of the project, a comparative evaluation between the RTE prototype version and Linux was conducted and confirmed to be equivalent in performance. TSUJI Kunihiko of Kyoto Microcomputer says, “The advantage is that the environment was similar to that of the actual development site, so it is highly compatible for users and easy to commercialize.” NISHIMURA Seiji of NSITEXE recalls, “It was very rewarding to be able to take on the challenge of rebuilding a variable length vector instruction technology that had been in decline.” GONDO Masaki of eSOL expresses his hope by noting, “In order to compete globally, it is essential for Japanese tool vendors to join forces and create an RISC-V software tool chain ecosystem. We hope that this project will help Japanese manufactures gain market share in cost-effective sectors such as automobiles and digital imaging where reliability, long recognized as a strong point of Japanese manufacturing, is required.”

GONDO Masaki (left)
CTO and Senior Executive Vice President, Software
eSOL Co. Ltd.

NISHIMURA Seiji (center)
Project Manager
Semiconductor IP R&D Unit
Development Platform Section
NSITEXE Inc.

TSUJI Kunihiko (right)
General Manager
Kyoto Microcomputer Inc.

Promising NEDO Startups

Startups growing into the future with NEDO's support

Innovator

File.21

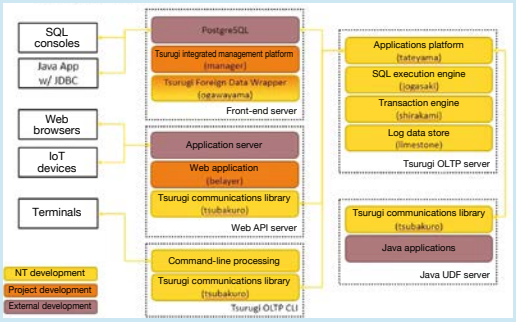
Nautilus Technologies, Inc.

President and Representative Director
MEGURO Yuichi

Providing systems integration, operation, and maintenance services focused on distributed processing technologies

https://www.nautilus-technologies.com/

Only available in Japanese



Overall diagram of Tsurugi

2011 Founding of Nautilus Technologies, Inc.
Release of Asakusa Framework OSS
2016 Release of distributed processing engine Asakusa on M³BP OSS
2017 Merged Ocean Bridge, Inc.
2018 Began development of Tsurugi under NEDO project
2023 Release planned for alpha version of Tsurugi OSS

Q1. How have you taken advantage of NEDO's support programs?

The first objective of this project was to provide dependable state-of-the-art OLTP technology for use in HTAP systems. With NEDO's support, we have been able to expand our team, develop applications and necessary tools, and conduct more advanced R&D activities.

The marketplace, however, is not receptive to developing only an OLTP solution. To gain market acceptance, we needed to develop an OSS connected with a Postgres system on the front end that demonstrated higher degrees of usefulness in actual applications.

Currently, companies in the Japanese IT industry cannot afford to invest in middleware on their own so we do not believe it would have been possible to realize our objectives without NEDO' s support.

Q2. What is Nautilus Technologies' vision for the future?

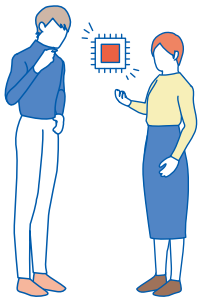
Our immediate goal is to deliver the OLTP we developed to the developers and user companies. In the history of the Japanese IT sector, this is the first release of a domestically developed OSS RDBMS with public funding support. Unfortunately, the Japanese IT industry believes that government-sponsored IT projects in the private sector are never successful so counteracting this way of thinking would be a positive first step.

We have already begun advance sales and other activities with the goal of releasing the product at the end of this fiscal year and have received feedback from user companies indicating strong interest in the product. Since our product development was supported by public funds, we would like to fulfill our responsibility and deliver our OLTP to the user companies. We will certainly do our best to meet the expectations of everyone involved.

NEDO Comment

Technology that can efficiently and rapidly process the ever-increasing volume of information flows is the foundation for the growth of Japanese industry. We hope that the company's software solution will be rigorously tested during its remaining development period and that it becomes Japan's first example of an IT technology whose development process goes against popular notions about government-sponsored R&D projects.

To revitalize the economy, it is important to foster entrepreneurs that have competitive innovative technologies.
NEDO provides startup support from a variety of perspectives to develop research and development-oriented startups and entrepreneurs.
Here, we examine notable startups that are continuing to grow toward the future.



Innovator
File.22

Floadia Corporation

CEO and President
OKUYAMA Kosuke

Pursuing semiconductor non-volatile memory IP business based on proprietary technology and development of AI chip technology based on semiconductor non-volatile memory

https://floadia.com/

Exhibition booth at SEMICON Japan in December 2021

2011 Founding of Floadia Corporation
2013 Start of development of semiconductor nonvolatile memory based on proprietary technology
2014 Start of production of nonvolatile memory products at foundry in Taiwan
2016 Start of development of computing-in-memory (CIM) technology based on application of non-volatile memory
2021 Presentation of CIM technology at SEMICON Japan
2022 Selected to participate in NEDO project Research and Development and Commercial Application of Ultra-low-power Edge AI Chips Based on Neuromorphic Dynamics. Selected to carry out CIM chip development under Tokyo Metropolitan Government's Innovation TOKYO Project for the Future.

Q1. How have you taken advantage of NEDO's support programs?

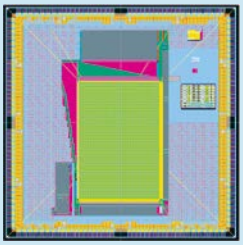
We developed 128-level analog programmable CIM technology by applying the quantum tunneling carrier injection method to our proprietary SONOS-type nonvolatile memory devices. Since 2020, we have been working with the Kyushu Institute of Technology on research for the application of this technology to neural networks.

By participating jointly with the Kyushu Institute of Technology on the NEDO project since 2022, we have been able to make concrete progress in development efforts aimed at realizing ultra-low-power edge AI chips based on CIM technology.

Q2. What is Floadia's vision for the future?

Our ultimate goal is to create an electronic brain using semiconductor memory.

While our current business is based on our proprietary semiconductor memory IP technology, under this NEDO project we aim to realize an edge AI chip using CIM with semiconductor memory elements.



Blueprint of test chip for reservoir computing (an AI machine learning model) fabricated on silicon chip to show proof of concept.

After the completion of the NEDO project, we will focus on semiconductor memory IP and edge AI chips as the mainstay of our business. Ultimately, however, we believe that basic memory and cognitive functions of the brain can be realized with our technology, so we aim to develop an electronic brain equivalent to its human counterpart.

NEDO Comment

To realize advanced information processing at the edge, it is essential to have chips that are compact and energy-efficient, yet also possess high processing power. We hope the NEDO project will help Floadia further enhance its technology and make a big leap forward from its beginnings as a startup.

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