



Collaborative Robot CRX

FANUC Corporation

**A collaborative robot that is easy to use,
even on the first try.**



■ Outline

Along with the aging population and low birthrate comes an increasingly insufficient labor force, and demand for a collaborative robot that can be automatized without a safety barrier in the manual manufacturing field is growing rapidly. However, despite this increase in demand, collaborative robots have still not yet become sufficiently widespread. The biggest reason that there has not yet been a collaborative robot that is both as easy as a smartphone or a toy to use and is highly reliable, safe, and doesn't break, even for workplaces where robots are not yet commonplace. With an aim to solve this issue, the Collaborative Robot CRX is a new robot developed to be safe, easy to use, and highly reliable. Even first-time users can easily operate it, and it has a simple, flexible automation that allows people and robots to divide the labor.

■ Characteristics of Collaborative Robot CRX

The Collaborative Robot CRX has three major characteristics: safety, ease of use, and high reliability.

(1) Safety

This began with the design, creating a rounded exterior that gives people a feeling of safety and willingness to work with it. A highly sensitive contact stop function ensures that the machine stops smoothly and safely with a light touch. The gap between the arms is large enough to prevent a person's arm from being caught. It is ISO 10218-1 certified for safety and can be used with confidence.

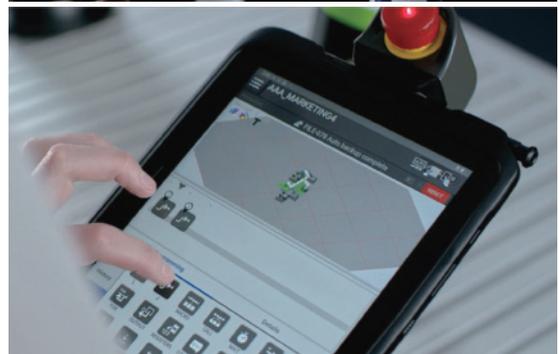
(2) Ease of use

The arm has been made as light as possible, it can be carried and installed by hand, and can be powered by AC100V, making it easy to install in any production site. The robot can be operated intuitively even if the operator is not familiar with robots. Users can create a teaching program through dragging and dropping icons with a finger, just like on a smartphone or tablet, without any specialized knowledge.

(3) High reliability

The highly-reliable design developed over many years includes

a maintenance-free arm that is dustproof and drip-proof. It can be used with peace of mind because it won't break, even in tough environments where it is exposed to water and oil.



Direct teaching and tablet operation

■ Achievements, development

In addition to the labor shortage, in this time of COVID-19, replacing some jobs where people work closely together with the Collaborative Robot CRX makes it possible to add more distance between people and avoid crowded conditions, which has made it very well-received. Demand is growing rapidly, and production capacity for the end of 2021 is scheduled to be three times higher than the present. The Collaborative Robot CRX responds to rapidly changing automation needs with its small footprint and ease of use that even first-time robot users can quickly learn.

FANUC Corporation

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Family Robot, “LOVOT”

Groove X, Inc.

**A home robot that stirs your instinct
to love “LOVOT”**



■ Outline

The LOVOT is a family robot that stirs the instinct to love. LOVOT uses technology to pursue not the usual robot qualities like efficiency and convenience, but a feeling of comfort and charming behavior when it is held. It gently influences people’s feelings and helps them feel happy. It draws out the power of love and gives people energy to face tomorrow.

LOVOT is filled with the technology that satisfies the conditions necessary for cuddling, which is essential for nurturing attachment with its beloved owner. Just like animals, the skin softly covers a skeleton, and the tires smoothly emerge from the body. In order for it to maintain a comfortable body temperature, it is also fitted with a heat mechanism. The upturned face is a sign that it wants to be held. The indents and round bottom of the body make it easy to hold and carry. The shape is based on two stacked spheres which gives it a natural form and contributes to improving the overall emotion expression of the body. Developers overcame the difficult task of including over 50 sensors to allow it to accurately grasp its owner’s whereabouts, while also retaining a huggable form. Although it is not alive, it moves independently, gets attached, and asks to be cuddled, which results in a lifelike presence that people can love without hesitation.

■ Social needs

Generally, technology has made people happy by improving productivity. However, in contemporary society, there are more nuclear families and people living alone, and personal space is becoming more important, resulting in increased isolation and loneliness. Under these conditions, keeping in mind our aging society and the threat of yet-unknown viruses, it is becoming more important to soothe people directly rather than focusing on improving productivity. In order to soothe feelings of loneliness and isolation, people need an object they can love without hesitation. One option is a pet. By interacting with pets and forming attachments with them, people secrete oxytocin (a hormone that

promotes feelings of peace of mind). This robot was developed with the idea of using the latest robot technology to reproduce the comfort that pets give to humans.

■ Achievements, development

At the CES 2020, one of the largest exhibitions in the world, where the latest technology comes together, LOVOT won the Innovation Award which is presented to products that are particularly outstanding, and was also selected for awards selected by top world media such as Refinery29 and Ici TOU TV. Additionally, it won the Cool Japan Award 2019, the Japan Society of Kansei Engineering (JSKE) Kawaii Award 2019, Japan Media Arts Festival Jury Selection, 2020 Good Design Gold Award, and more. In addition to its cute appearance, simple movements, and its warmth, softness, and gaze when held, it was also given high praise for its functional value with features that protect loved-ones such as keeping watch and staying home alone. Expectations are high not just for consumer appeal but also for implementation at welfare facilities, medical institutions, educational institutions and companies.



LOVOT at work in a variety of situations

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Asteroid Explorer Hayabusa 2 Asteroid Exploration Robot MINERVA-II

Japan Aerospace Exploration Agency (JAXA)
Hayabusa 2 Project Team
MINERVA-II Project Team

Sample return mission from deep space

■ Deep space exploration robotics technology ahead of the world

Outer space is a region that humans can't generally just reach out and touch, so we have continued to make mistakes, unable to work towards success with trial-and-error, but instead requiring highly reliable spacecraft. However, with deep space, a place where humans have never gone and careful investigation is required, high reliability must be combined with ambitious exploration, combining two essentially opposing ideas. In this unique environment, Hayabusa 2 succeeded in touching down and gathering samples twice, flexibly adapting to the unknown environment that only became known upon arrival and maintaining a steady level of reliability. It was controlled through two methods: the Human in the Loop method which is based on commands from Earth, and autonomous functions of the spacecraft such as the event-driven control sequence function and artificial features such as target markers.



Hayabusa 2 tracking the target marker

■ Compact and light autonomous exploration robot MINERVA-II

The MINERVA-II are twin robots that were put on board Hayabusa 2, with the goal of performing mobile exploration on the surface of the asteroid Ryugu, which is just under 1km in size. The robots are 18cm in diameter and 7cm tall (excluding protrusions), and each one is extremely small and light with a mass of just over 1.1kg. They are powered by solar cells attached to the surface. The robots are equipped with mechanisms, cameras, sensors, and radios to move by hops in the very small gravity environment of the asteroid surface (approximately 1/100,000 compared to Earth). Since there was a big communication time lag (approximately 40 minutes round trip) between the asteroid and earth, the software on



board the robots had algorithms enabling them to operate completely autonomously without commands from Earth.

■ The world's first celestial body surface exploration robot

The two robots were launched from the mother ship to the asteroid on September 21, 2018. Rover 1A observed the asteroid's surface from multiple locations for 113 asteroid days (approximately 35 Earth days) until October 26, 2018. It sent a total of 609 images of the surface of the asteroid to Earth. During that time, it covered approximately 1/4 of the asteroid's surface.

Rover 1B was active from September 24, 2018 for ten asteroid days, and took 39 images.

This feat was the world's first mobile exploration of the surface of a small celestial body in our solar system. The robots were also the first from Japan to directly explore the surface of a celestial body.

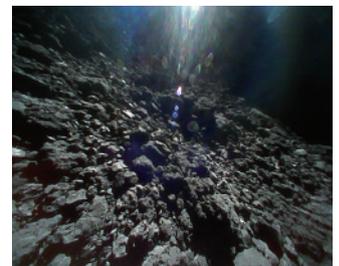
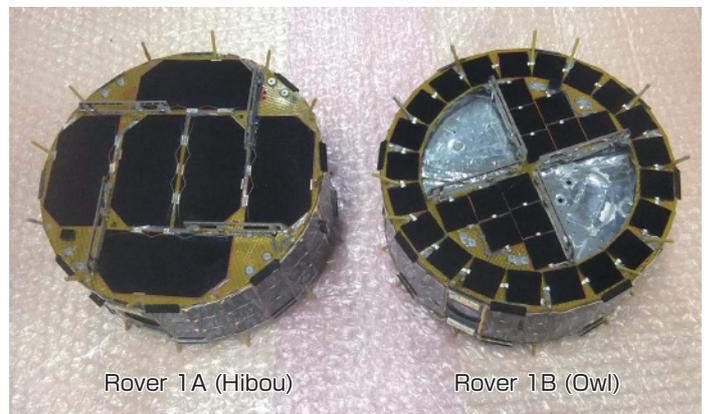


Image shot by MINERVA-II



Two MINERVA-II robots

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Mobility Support Robot HUG T1-02

FUJI Corporation

Supporting mobility by using an apparatus to assist standing



■ Outline of mobility support robot Hug

Fuji Corporation developed mobility support robot Hug in order to reduce the burden on caregivers with funding from the Project to Promote the Development and Standardization of Robotic Devices for Nursing Care conducted by the Ministry of Economy, Trade and Industry and AMED. It aids people who have difficulty standing by helping them to transfer (move) from a bed to a wheelchair or other locations such as the bathroom.

When moving, the care receiver leans forward against Hug, and the caregiver pushes the "stand" button to start the stand movement.

Hug T1-02 retains the original concept while renewing the design to make it an even more acceptable product for both care receivers and caregivers.

It not only reduces the burden on caregivers, but can also support the care receiver in continuing to live life with a high degree of independence.

■ Practicality in a caregiving environment

1. Uses and maintains the strength of the care receiver

Hug has the user lean forward and helps them to stand up by supporting the chest and raising the buttocks. A two-axis motor works in concert to help the part supporting the chest move in a natural standing motion. Standing up with Hug uses the same movement as a person standing up, shifting the center of gravity to the feet. The caregiver can talk to the care receiver while using the machine to enable the receiver to be aware of standing and participate in the movement.

2. Reduced burden and change in awareness

By leaving heavy lifting up to Hug, the caregiver no longer has to spend energy lifting and can focus on other aspects of care. From the perspective of the care receiver, they go from being lifted by a caregiver to using a device to stand, changing their image of the role of caregiver from "a person who lifts me up" to "a person who cares for me." This also helps eliminate the issue of care receivers feeling reluctant to move because of the physical burden it places on the caregiver.

3. Makes going to the bathroom easier

By enabling the care receiver to stay in a standing position, it is

easier to take care of bathroom needs such as removing trousers, wiping the buttocks, and changing diapers. The device is compact and lightweight, making it easy to maneuver even in an enclosed space. When sitting on the toilet, leaning on the Hug can help with bowel movements by applying pressure on the abdomen.

4. Simple operation

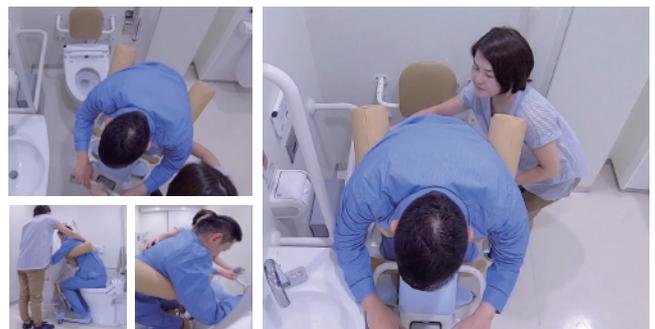
It is operated with just two buttons: "Stand" and "Sit" which makes it easy to use even without any specialized robot knowledge. It's easy to implement at care facilities, assisting work quickly and efficiently without getting in the way of other tasks. For families doing in-home care, the device can be used without having to spend time and energy figuring out how to use it.

5. Reduces falling risk

Hug supports a specific stable movement and operates no matter the ability or strength of the caregiver, reducing risk of falling. It lets the care receiver down gently, reducing risk of compression fractures.

■ Implementation and spread

Since sales began, approximately 200 Hug T1-02 units have been put into use, and over one thousand units for the series overall. Helping a person get up and move to another place, and helping them in the bathroom is extremely physically demanding work. Hopefully this device can be implemented and used in more and more situations in order to reduce the burden on caregivers and help care receivers live long, comfortable lives.



Bathroom usage example

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Next Generation Agriculture Partnership Through automated vegetable harvesting robots And RaaS modeling.

inaho Inc.

Changing the future of agriculture through technology



Management issues and labor shortages affecting Japan's agriculture

Agriculture in Japan is projected to decrease by half in the next 15 years due to the aging population. There is already a labor shortage preventing expansion of cultivated land, and many farmers do not expect to improve their yields.

Agriculture is considered to be hard labor with few breaks, but in fact when it comes to production of certain vegetables, some require daily harvesting for over half of the year. inaho has been working to develop technology such as AI (artificial intelligence) to provide robots that can act in place of people to harvest crops and make more time for farmers.

Crops that can be harvested by the inaho robot

inaho divides crops into two categories. Harvesting of produce that is ready for harvest all at once and can be harvested together is called "batch harvesting" and harvesting of produce that grows at different rates and must be harvested as it ripens is called "selective harvesting." Crops such as rice and potatoes are harvested using batch harvesting. A harvester is used to collect it all at once, and the work is not strenuous. However, crops that

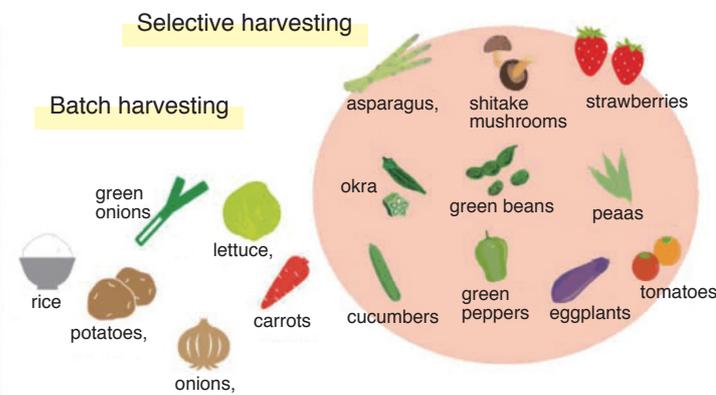
require selective harvesting such as asparagus, tomatoes, eggplants, cucumbers, and so on are difficult for machines to determine whether a specimen is ready to harvest, so until now automatic harvesting had not made much progress in this field. At inaho, a robot has been developed that uses AI to determine whether to harvest or not, which has made it possible to automate the harvest. An automatic harvesting robot that collects asparagus was implemented, and it has been providing its services in Saga prefecture since September 2019.

Outline of robot structure and automatic harvesting service

The robot has an electrically-powered cart, a camera and sensor to determine what to harvest, and an arm to do the harvesting. It works via these three steps of moving, exploring, and harvesting. It is equipped with a light so it can work at night. With asparagus, it matches the harvesting standards with the shipping standards and can be set in one-centimeter increments. The harvest speed is 12 seconds per stick, and it is powered by a battery that can be recharged on a household outlet.

Rather than selling the robots, inaho provides them as a service using the Raas (Robot as a Service) model. Consumers can choose to pay a fixed rate or pay a flexible rate based on harvest volume. Compared to the traditional business custom of purchasing agricultural machines, there is low setup and maintenance cost, and the period of use is flexible.

The company is considering doing consulting with consumers to provide advice on the best field environment for harvesting using data gathered while working, in order to use the robots more effectively. The types of harvesting will be expanded to include tomatoes, cucumbers, strawberries, eggplants, green peppers, and more, while also working to lighten the load of other farming operations such as pest control, leaf raking, and transportation. As a service provider working together with producers, the company hopes to change the future of agriculture with the power of technology to improve productivity.



Batch harvesting and Selective harvesting

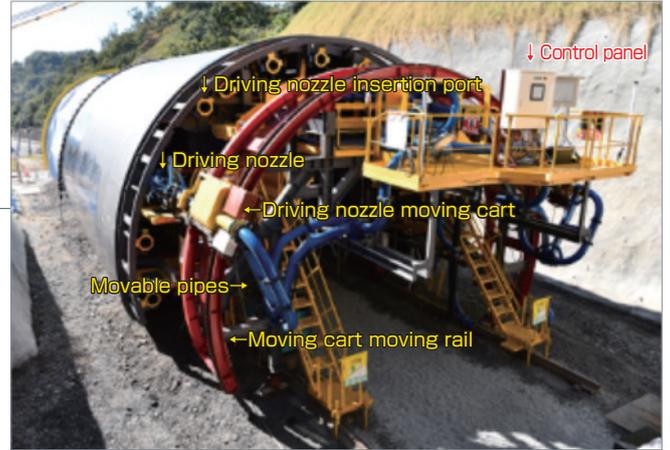
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Concrete tunnel lining Automatic construction robot system

West Nippon Expressway Company/
Shimizu Corporation/
Gifu Industry Co., Ltd.

Automatic concrete tunnel lining construction robot system achieves high quality concrete linings

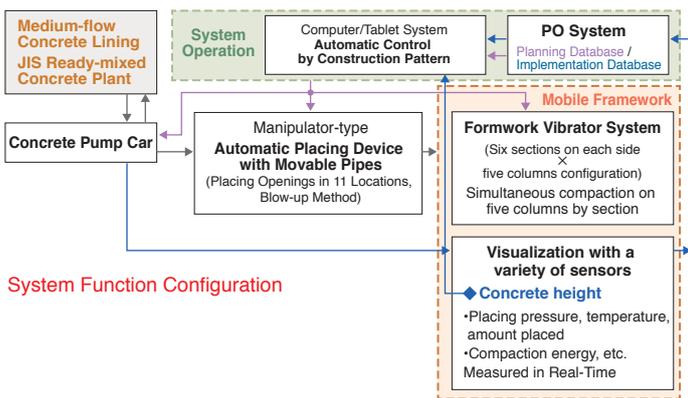


Full view of the system

Outline of automatic concrete tunnel lining construction robot system

The automatic concrete tunnel lining construction robot system automatically controls the progress of a series of operations, from placing, compaction, stopping, and demolding of concrete lining used in mountain tunnels. It consists of a manipulator-type placing device and a computer system that controls the formwork vibrator automatically.

A characteristic of this technology is that it is an automatic construction method that makes use of the flow characteristics of medium-flow concrete lining. Fresh concrete with excellent fluidity and no material separation is automatically poured using the blow-up method into the movable formwork using a computer-controlled concrete pump and a manipulator-type placing device, and the pattern is automatically compacted using a formwork vibrator. The construction status and compaction status are constantly quantified and visualized by various sensors, which makes it possible to determine when to move on to the next section and enables automatic operation.



System Function Configuration

Development background

Concrete lining in mountain tunnel construction has until now depended on the experience and intuition of skilled workers, and ensuring the quality of construction has become a serious challenge. As many of these skilled workers begin to retire, there is also a need for measures to reduce the workload of concrete lining construction as skilled workers are most needed for placing and

compacting concrete in narrow spaces. This is the reason for developing a machine that mechanizes the work of placing and compacting the concrete lining, in order to free workers from tedious work and dramatically improve the quality and speed of tunnel construction.

Results gained by introducing the system

The introduction of this system enables the construction of dense, solid, and high-quality concrete lining that reaches the target quality, has no variation in strength distribution and surface properties, and has a good surface finish.

With the mechanical construction via computer system, manual work is replaced by mechanical work, and the role of the workers changes greatly, to that of checking the construction status and monitoring the system

Future developments

The accumulated measured data will be analyzed and developed into a learning-type automatic concrete lining construction system that can respond to changes in the properties of fresh concrete, which will be developed into a common technology for mountain tunnel lining, and contribute to the establishment of lining technology.

On-site implementation

As of December 2020, the system has been installed at three sites (total 911m, 9,257m³), and there are plans to introduce the system to many more sites in the future.



System operation screen

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The Robot Award

SME Venture Prize (Small and Medium Enterprise Agency Director-General Award)

Collaborative Transportation Robot Thouzer Series

Doog Inc.

A collaborative transportation robot that can be easily used by anyone.



■ Functionality and characteristics of the Thouzer series

The Thouzer collaborative transportation robot is similar to conventional AGVs in that it has a line travelling function, but it also has automatic tracking and memory tracing functions. The automatic tracking function uses an infrared laser sensor (LiDAR) to recognize a person standing in front of it, and then tracks the person as they move. It can follow the operator anywhere while avoiding obstacles, and its carrying capacity can be flexibly expanded by connecting multiple Thouzers in a row. The memory trace traveling function, a unique technology developed by Doog, enables autonomous traveling by storing the route traveled by following the operator and tracing the memory. All the operator has to do is push the memory tracing button, and the Thouzer will follow the operator while saving LiDAR data frame by frame, memorizing the scenery around the route it has traveled. Once the route has been travelled once and memorized, the operator can push the replay route start button to have it autonomously travel the same route, referring to the memorized scenery. While general SLAM-type guideless AGVs require specialized technicians to build and change maps, that method is time-consuming and costly. The memory tracing system enables workers onsite to simply walk the route once and store it in the Thouzer, making it possible to change the route easily and flexibly, even if the environment changes weekly or even daily.

The Thouzer can also be customized in various ways. In addition to hardware customization such as attaching walls and shelves to the base unit panel, the main product, the Thouzer E Series, has expandability to add applications and link external devices via a network.

■ Benefits of implementing the Thouzer

The following benefits can be enjoyed by implementing a Thouzer:

- 1. Greater automation and efficiency of work:** For example, of the picking and shipping work that workers would ordinarily do all on their own, the work of carrying the items to the shipping area

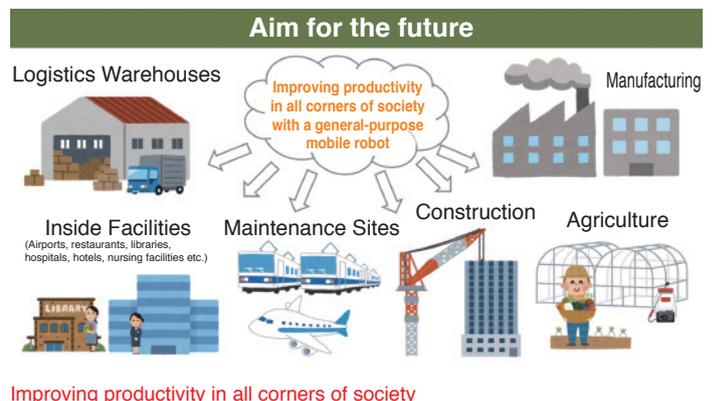
can be done by the Thouzer using line tracing and automated by memory tracing. The Thouzer can also pull another cart to do double the labor a human could, making it possible to have a more efficient operation with fewer people.

- 2. Reduced burden on workers:** By having the Thouzer do the transport work, the labor of moving heavy objects and walking long distances by the workers is reduced, making their physical burden lighter.
- 3. Avoidance of contact:** In particular with COVID-19, deliveries can be made without direct contact with people, for example to places where infected people are staying.

People at places where the Thouzer has been implemented have praised it for its easy implementation, easy operation, and operational flexibility.

■ To every corner of society, through a variety of partners

Thouzer is being implemented in a variety of sites through several partners. Doog provides base units and technical information for customization, and the partner companies provide customization, system construction, and maintenance services based on their unique strengths, with the aim to spread the product to every corner of society.



Improving productivity in all corners of society

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The Robot Award

Japan Machinery Federation
President's Award



“meviy” and the digital revolution for parts procurement in the manufacturing industry

Misumi Group Inc.

Promoting DX (digital transformation) in the manufacturing industry and achieving labor productivity reform



■ Outline of meviy

meviy is an e-commerce service that streamlines the procurement of machined parts in the manufacturing industry. The design data is simply uploaded to meviy (<https://meviy.misumi-ec.com/>), the AI recognizes the shape and immediately estimates the cost, processes the part, and delivers it in the shortest time possible in this innovative manufacturing platform. The platform's target uses are mechanical parts used in production equipment, devices, jigs, and more. It can be used to procure metal mold parts, prototypes, sheet metal parts, cutting parts, and any other customer needs. Since it is a web service, the only necessary equipment is a browser. Membership registration is free, and the service is available 24 hours a day, 365 days a year.

■ Two innovative technologies

meviy implements two innovative technologies: AI-powered automatic estimates, and digital manufacturing.

- 1. AI-powered automatic estimates:** Misumi Group's own algorithm analyzes the shape of the design data, plans the manufacturing process, and automatically calculates the cost. Customers can also specify the processing method and accuracy in microns on the browser, and the estimate will immediately be updated when the part information is changed.
- 2. Digital manufacturing:** This system automatically uses the design data to generate the programs necessary to operate the machine tools and automatically manufacture the part. Normally, for custom-made products, a skilled CAM operator must create NC programs to run the equipment from CAD drawings.

■ The “time-generating effect” of meviy

1. No need for paper drawings

Just upload the design data, and there's no need to create paper drawings which typically takes about 30 minutes per drawing.

2. No more waiting for an estimate

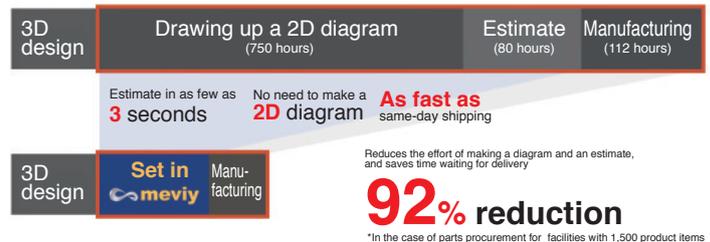
Prices and delivery times are immediately analyzed and estimated by AI after the design data is uploaded.

3. Reliable, quick delivery

Digital manufacturing means the shortest-possible turnaround is same-day shipment.

(Typically, it takes about two weeks for parts to be delivered.)

The above effects not only dramatically streamlined the parts procurement process, which has always been full of inefficiencies, but also enable people to procure parts more cheaply and more quickly than before.



The time-generating effect of meviy

The value that meviy provides is time generation. Misumi Group aims to contribute to the realization of a prosperous society where the manufacturing industry is full of creativity, and eventually Society 5.0, which Japan is aiming to achieve, will be made a reality, where systems can be left to complete low value-added work, and humans have more time to do the creative work in which they excel.

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The Robot Award

**Japan Machinery Federation
President's Award**

Autonomous mobile security robot SQ-2

SEQSENSE Inc.

Highly autonomous mobility functionality reduces the human burden of security work and achieves high levels of sophistication



■What is the Autonomous Mobile Security Robot SQ-2?

The SQ-2 is an autonomous mobile security robot created by making full use of advanced technologies such as 3D sensor technology, self-positioning algorithms, and real-time path planning algorithms. It is capable of performing security patrol work in place of or in cooperation with humans, a job for which there is a serious lack of available workers.

Equipped with a proprietary 3D LiDAR system, the security robot can perform detailed 3D mapping of properties to be guarded, detect moving objects such as pedestrians, and detect changes in the environment. The system can also be linked to a cloud system to provide various security operations (patrol, standing guard, moving guard) remotely from the security base.

■Work Type

Patrols

The robot moves autonomously to predetermined patrol points and performs monitoring and inspections. During the patrol, the robot is equipped with a camera (frontal high-definition or panorama) to stream video in real-time. It takes photographs at each point in the patrol and saves it to the cloud system making it possible to check for abnormalities after the patrol is completed.

Standing Guard

The robot stands at a security point and performs surveillance. Images from the 360-degree panoramic camera can be displayed on a monitor installed at the security base. It is possible to monitor the area around the security point in real time. The onboard microphone and speaker make it possible to use it to respond to enquiries in the field.

Moving Guard

The robot can be operated remotely from the security base. By specifying any point on the map, the robot will move autonomously to the point. If a suspicious object or an injured person is found during a patrol operation, the robot can be

moved to check and talk with the subject.

■Reliable technology to support work

The proprietary LiDAR system on board the SQ-2 is capable of perceiving the robot's vicinity from a high angle, enabling flexible and safe autonomous movement, even in large-scale environments that require security. The software stack that uses the data from the sensors is based on self-positioning and path planning software, which is also available as open-source software, making it possible to make advanced adjustments and customizations.

With the connected cloud system, security work that uses the internet can be done and robot operation management applications can be built, enabling both flexible functional expansion and ease of operation as the system can be used anywhere with a web browser. The system can also be smoothly connected to external systems such as elevators. Application-wise, the company plans to incorporate daily field requests, eventually proactively offering recognition functions to support security operations.



SQ-2 on patrol

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Next generation pharmacy robot (automatic pharmaceutical management), automatic pharmaceutical dispenser, and digital shell OTC sales achieve a “Vision of a drug store for patients”

Nippon Becton Dickinson Company

Using automation to create more time for pharmacists.
Teaming up with medical institutions to support a shift to value-added work.
Contributing to better quality of life for citizens.



What is the pharmacy robot BD Rowa™ solution?

The BD Rowa Vmax™ System is an automated storage and dispensing system that can take responsibility for managing most of the inventory (prescription and over-the-counter drugs) handled by pharmacies. It supports pharmacists and people working in pharmacies by storing, picking, doing inventory control, stocking shelves, and managing expiry dates, to allow people to shift their work to higher value-added tasks.

The system can also be connected to the following two optional products to increase the value of the entire pharmacy, supporting not only the staff but also improving the customer experience (CX).

1. Automated drug pickup machine (BD Rowa™ Pickup Terminal)

The terminal enables non-face-to-face pickup of prescription medications 24 hours a day, 365 days a year. Prescription medication can be picked up any time without needing to meet anyone, including the same day, after instruction is given on how to take the medicine, either online or in-person. This is a highly flexible solution achieved in a first for Japan thanks to the gray zone elimination system.

2. Digital signage for OTC sales support (BD Rowa Vmotion™ Digital Shelf)

This is a tool that assists pharmacists in explaining OTC drugs to patients by displaying package and package insert information on a screen. OTC drugs can also be dispensed to the pharmacist or other employee by simply selecting them on the screen, allowing them to explain or ring up the sale without interrupting the customer interaction. It also eliminates the time and space required to display OTC drugs and eliminates the need to conduct inventory management.

Expected Social Impact

In Japan's super-aging society, medical insurance finances and nursing care have been cited as major issues, and pharmacies and pharmacists are expected to play a major role in improving medical care. The national government has set forth a "Vision for Patient-centered Pharmacies" that calls for all community pharmacies to have so-called family pharmacy capabilities by 2025. It calls for the centralized and continuous monitoring of patients' medication information, pharmacological management, guidance to check for duplicate doses and interactions



Scene of a next-generation pharmacy with the BD Rowa™ Solution

between prescribed drugs, improving adherence through medication guidance, promoting home dispensing for patients, and promoting collaboration between pharmacies and medical institutions, to shift the pharmacist's tasks from pharmaceutical-centered (physical) to patient-centered (interpersonal).

The BD Rowa™ Solution will contribute to the task shifting of pharmacists from physical to interpersonal tasks, aiming to create a society where each citizen can think and act on their own health.

Implementation record

Since the first system was implemented in Japan in March 2019, the system has been installed all over Japan, from individual pharmacies to major dispensing chains and drugstores with more than 500 locations. The system has been installed in all types of pharmacies (by university hospitals, by hospitals, by clinics, on the grounds of hospitals, at pharmacies that service several small clinics, in front of train stations, inside medical malls, at drugstores, and in pharmacy distribution warehouses). It has been well-received and some customers have even installed the system in multiple stores.

Fun Facts about BD Rowa™

1. Peace of mind with traceability function for pharmaceutical product recalls

All inventory is managed by ID, which enables checking products by the month for their expiry dates that enables removal of expired products all at once. Not only that, but the prescriptions and lot numbers are connected so that in the event of a recall they can be traced.

2. High efficiency storage and high-speed dispensing

By optimizing inventory (rearranging boxes) during free time, highly efficient storage can be achieved in a limited space. Also, multiple boxes can be picked simultaneously for high-speed dispensing.



BD Rowa™ Pickup Terminal



BD Rowa Vmotion™ Digital Shelf

Contact:

Nippon Becton Dickinson Company

Address: Akasaka Garden City 4-15-1 Akasaka, Minato-ku, Tokyo
Customer Service Tel: 0120-8555-03

View product details here ▶





The Robot Award

First Prize

(Nursing Care, Medical Care, and Construction Category)

RoboRack®, an automatic breeding system for research mice

Global Linx Technology Co., Ltd.

Gentle on people and mice alike,
proposing a new breeding method



■What is RoboRack® ?

RoboRack® is the world's first robot that automatically breeds mice used for medical and other research experiments.

To outline what is involved in raising mice:

1. **Changing bedding (Replacing old cages with new, and providing new bedding)**
2. **Feeding (Giving food to the mice)**
3. **Watering (Giving water to the mice)**

And more. But until now, this has all been done by hand.

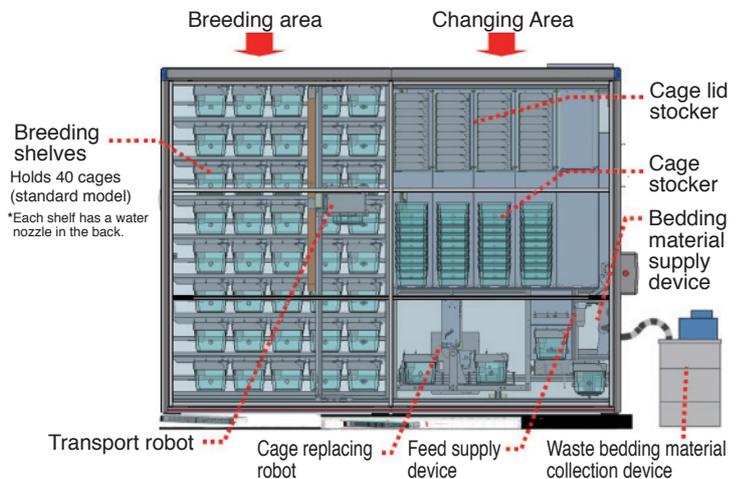
Research for the RoboRack® began seven years ago. It does all these things without the need for human hands.

■Current situation and issues with animal testing

Animal testing is necessary for developing medical technology, pharmaceuticals, agricultural chemicals, chemical products, cosmetics, food additives and more. It is used to study the safety, efficacy, and danger of all kinds of substances. In particular, in the fields of medicine and pharmacology, animal testing is very important, as it is an essential step before clinical experiments (clinical trials) can be held. In recent years, animal testing has been used in the development of new drugs for the treatment of cancer and other incurable diseases, as well as in the development of regenerative medical technology such as IPS cells. Its importance is being increasingly recognized as it has played a valuable role in fighting COVID-19, which is now raging worldwide.

Meanwhile, in recent years there has been a strong demand for appropriate animal experiments from the perspective of animal welfare, and research institutions are taking the utmost care to avoid causing unnecessary pain and stress to laboratory animals. However, in reality, it is very difficult to take practical measures such as maintaining breeding standards.

In addition, due to the spread of COVID-19 that has been rampant since last year, access to experimental facilities is limited, making it extremely difficult to secure staff and work hours at sites that are already facing a labor shortage.



■Thanks to automation with RoboRack®

Until now, it has been considered difficult to automate the breeding of laboratory mice, and breeding has mainly been done manually. The RoboRack® has automated this breeding work, which not only reduces the workload of animal caretakers, but it also avoids risk and improves the accuracy and reproducibility of experiments by limiting the contact between humans and animals. The company believes that this will contribute to the development of medical science in Japan and around the world by making it possible to conduct experiments that meet a wider range of requirements.

The RoboRack® also provides excellent care for laboratory mice. Thorough attention to detail means that noise has been limited in order to prevent unnecessary stress to the mice. To watch a RoboRack® in action, see the company's website for a video:

<http://www.glinx.co.jp/products02/index.html>

It goes without saying that the development of medical research will continue to play an important role in ensuring a healthy life for mankind. Global Linx Technologies are convinced that RoboRack® will revolutionize the medical research industry.

Contact:

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Retrofit type automation system for agricultural equipment

Topcon Corporation

Turn your tractor into an automated tractor



Automatic steering system

■Challenges facing Japan's agriculture industry

Due to the extreme aging of the farming workforce in Japan, an increasing number of farmers are outsourcing the management of their fields to other farmers in the region. In order to handle the management of this increased area, they are incorporating, hiring workers, and treating it like a large-scale farming operation. However, it's not easy to manage a large field while dealing with an unskilled labor force at the same time. In particular, the operation of agricultural vehicles requires a lot of skill, as it is difficult to keep the vehicle moving in a straight line, and the driver needs to also operate the machinery hooked to the back (fertilizer, pesticide sprayers, etc.) In particular, ridging, sowing, and other operations require skilled driving with an accuracy of several centimeters.

■An automatic steering system that can be retrofitted

The automatic steering system uses a high-precision GPS receiver that registers position information, which is then used to automatically control the steering wheel of the agricultural vehicle to have it follow a pre-registered line of travel. The system is composed of three devices: **1. High-precision GPS receiver:** It has a built-in electronic compass and IMU (Inertial Measurement Unit), which measure the location, position, and bearing. **2. Console:** This processes the position and bearing information from the GPS receiver and also displays and sets the position and bearing information. It uses the location information to control the farm equipment. **3. Electronic steering wheel:** A high torque electronic motor is installed to automatically operate the steering wheel of the vehicle. These devices can be retrofitted to existing vehicles that are currently in use, enabling automation at a low cost. Since agriculture vehicles are used for a short time in each season, a single automatic steering system can be passed around to different vehicles for efficient operation.

■Making difficult work easier for unskilled workers

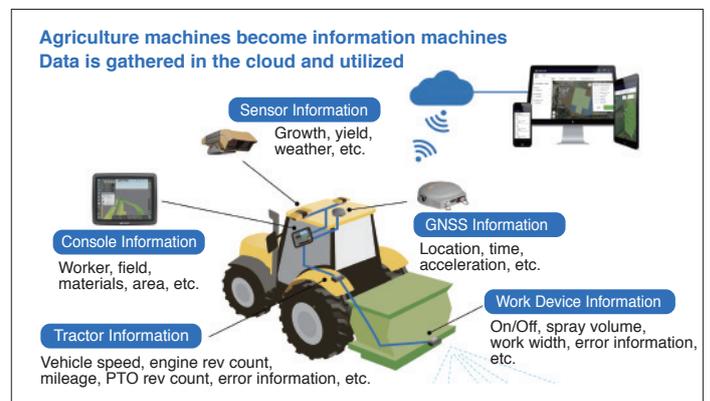
With the automatic steering system, even unskilled workers can perform highly accurate and efficient work similar to skilled workers. By delegating difficult tasks to unskilled workers, one of the obstacles to scale expansion can be resolved. For skilled operators

too, letting the system handle the steering wheel helps reduce fatigue and also lets them concentrate on checking the work equipment, allowing them to perform more accurate work. The system is particularly effective when operating at ultra-low speeds (0.1km/h) which is often the speed used in agriculture in Japan.

■Supporting DX (digital transformation) in agriculture

Automatic steering systems are rapidly gaining popularity in Japan, but they have already become common in advanced agriculture countries in Europe and the United States. Agricultural vehicles and work equipment are highly computerized and automatically controlled in conjunction with the position information of the automatic steering system. The automatic steering system collects data and sends it to the cloud and is managed by a system called FMIS (Farm Management Information System).

Meanwhile, in Japan today, automatic steering systems are only used to control the steering wheel and the recorded work data is not utilized. As Japan's work equipment becomes more electronic, it will be possible to obtain useful information. As agriculture machines become information devices, Japan will be able to utilize agricultural work data as is done in Europe and the United States. This will contribute to the transition from agriculture that relies on experience and intuition to one that is based on data.



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The Robot Award

First Prize (Social Infrastructure, Disaster Response, Fire Fighting Category)

A⁴CSEL[®] (quad-accel)

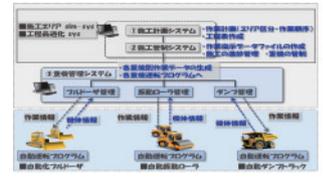
The next-generation construction production system with automatic operation of construction machinery at its core

Kajima Corporation

Turning civil engineering sites into state-of-the-art factories



A⁴CSEL development concept



A⁴CSEL configuration



In-use on site (embankment dam, 2018)

■Outline of A⁴CSEL

The A⁴CSEL (Automated/Autonomous/Advanced/Accelerated Construction for Safety, Efficiency, and Liability) was developed to solve important issues in the construction industry such as the shortage of labor and skilled workers, construction productivity, and industrial accidents. It is a construction like none other, that automates general-purpose construction machines, and allows multiple machines to operate automatically at the same time to perform work without the need for a lot of manpower. By sending work data, the automated construction machines can perform routine and repetitive tasks automatically and unattended. By operating a large number of machines simultaneously and with a minimum of personnel, productivity and safety can be greatly improved. The A⁴CSEL consists of the following: **1. Technology to modify general-purpose construction machinery to automatic operation specifications.** **2. Technology to ensure stable quality work regardless of site conditions by incorporating AI-analyzed data of skilled workers into the automatic operation control.** **3. Construction management technology that coordinates a large number of machines and operates them based on the most productive construction plan.** These technologies make it possible for all machines to operate autonomously and automatically based on a plan that optimizes the placement of construction machines and the order of work. The automation of the three main types of construction equipment used for earthwork, namely vibratory rollers, bulldozers, and dump trucks and the automation of the work performed by these machines has made progress and has been implemented at four sites so far.

■From labor-intensive to information-intensive

In many construction sites, each job is left up to the worker, and as a result, the efficiency has been left up to individual skills that are difficult to quantify. In order to change such qualitative and highly variable production efficiency into stable quantitative values, A⁴CSEL analyzes the onsite work, including the work that requires experience and skill, and reconstructs and standardizes it into a combination of routine and repetitive actions. The company is also building a highly productive construction production system by implementing methods of optimizing the production process that has been cultivated in manufacturing plants. Through these efforts, the company is transforming construction sites, which are

considered to be typical of labor-intensive industries, into production bases for knowledge- and information-intensive industry.



A⁴CSEL at work (@CSG Dam 2020)



Developing the system at the life-size construction test site

■Future Prospects

At the life-size construction test site, the first of its kind in the industry, modification to automatic operation specifications, improvement of automatic operation performance, and the study of construction methods suitable for automatic operation are continuously being carried out under the same working environment as a real site. The company plans to continue to increase the number of automated machine models and expand the technology to other types of construction work, using A⁴CSEL to dramatically improve productivity and safety while also achieving the factorization of civil engineering sites.

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A 4K high-resolution deformation detection system for concrete linings of expressway tunnels traveling at 100km/h

Tokyo University /
Central Nippon Expressway Company Limited

Detecting cracks 0.2mm and up from a vehicle traveling at 100km/h



■A need for more frequent infrastructure inspections

About 30% of the tunnels on expressways have been in service for more than 30 years, and there is a need for more efficient inspections to prevent accidents due to deterioration. Detailed inspections of concrete tunnel lining are conducted by inspectors once every five years, but from the perspective of cost and accuracy, road administrators have been seeking a system that enables more frequent and accurate inspections. A traveling inspection system has been available in the past, but this system has been developed to meet the needs of users even better. The system is capable of capturing high-resolution images of cracks as small as 0.2mm while traveling at a speed of 100km/h. By identifying deterioration and damage at a higher frequency without the need for traffic control, special vehicles, or inspectors, this system will contribute to the achievement of a society in which a safe and strong infrastructure can be operated at a lower cost.

■4K High Resolution Deformation Detection System

This system uses a high-speed camera, high-speed image processing, and a rotating mirror to compensate for motion blur in real time, enabling the continuous capture of 4K-level images that are comparable to still images. Using optical axis control technology with the rotating mirror, they have succeeded in extending the exposure time, downsizing the equipment, and increasing the resolution of the captured images. The higher resolution allows the system to be used even in areas where it is difficult to see deformations due to soot and so on, and the longer exposure time reduces the amount of light required, which helps prevent distracted driving of other drivers and ensures the safety of the inspector.

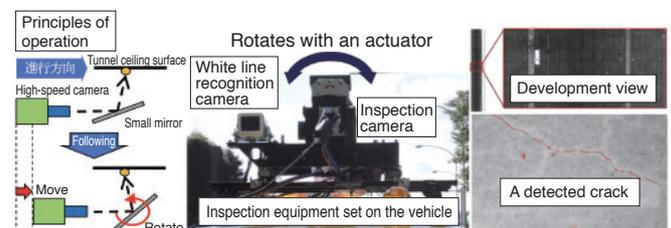
The device can be installed on the top of a regular vehicle (Toyota Surf in the photo here) using a commercially available roof carrier. Since patrol vehicles travel on highways many times a day, it is possible to conduct inspections simply by mounting the device on the vehicle and setting it to record.

Although only one camera is installed in order to reduce the size of the system, the servo motor switches the imaging angle in a circular pattern as the vehicle travels. Using real-time vehicle position information gathered from the white line recognition, the system accumulates data from the target angle, creating a development view of the tunnel.

■Achievements and Future Developments

A field test was conducted on an unrestricted expressway. As a result, the system was able to detect cracks of 0.2mm at a speed of 100km/h within the restriction of the Tomei Expressway Nihonzaka Tunnel. In addition, development maps were successfully created for the Kuragaike Tunnel on the Tokai Ring Road (at 100km/h) and the Hida Tunnel on the Tokai-Hokuriku Expressway (at 70km/h). The images were processed by the deformation detection program, and cracks of 0.2mm or larger were detected, confirming the effectiveness of the system.

The system has succeeded in detecting not only cracks in tunnels while in motion but also internal deformation such as floating and peeling by applying the system to thermal camera imaging. In the future, the system is expected to contribute to the inspection field where both high accuracy and high efficiency are required by applying the same technology to inspection of transportation infrastructures such as railways and airplane runways, as well as high speed inspection of things like factory lines.



Inspection system outline

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Offshore and underwater robot systems that make a mothership-less seafloor survey system possible

Team KUROSHIO

(Japan Agency for Marine-Earth Science and Technology; Institute of Industrial Science, University of Tokyo; Kyushu Institute of Technology; National Institute of Maritime+ Port and Aviation Technology; Mitsui E&S Shipbuilding; Nippon Marine Enterprises; KDDI Research, and Yamaha Motor)

Bringing together technology from eight institutions from industry, academia, and government.
Ranked number two in the world



■ Outline

Typically, underwater robots used for seafloor surveys are transported and deployed to the sea by a manned support vessel and controlled by acoustic communication from the vessel. In order to further expand the use of underwater robots, Team KUROSHIO developed a mothership-less seafloor survey system which enables surveying of the seafloor using only robots without using a mothership. The system consists of an Autonomous Surface Vehicle (ASV), multiple Autonomous Underwater Vehicles (AUV), and a land-based station, and the operator remotely monitors and controls the ASV and AUV via satellite communications.

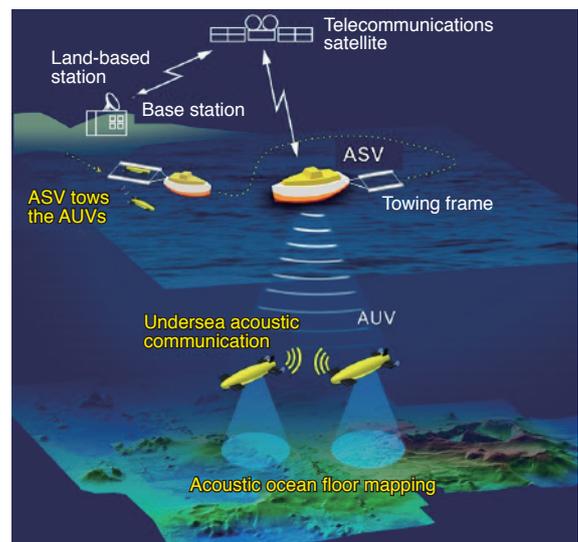
■ Features of the system

As the system has no mothership, in order to transport and deploy AUVs using the ASV, a towing frame was developed that can be customized to suit the AUVs to be transported. The towing frame is a buoyant body equipped with a mechanism to hold AUVs at two points and can transport AUVs of various shapes while cooling them with seawater. The AUVs and ASV can communicate wirelessly during transportation, and when the AUVs are detached from the towing frame, they will automatically start diving and surveying. In this system, the ASV is equipped with a satellite communication device and an underwater communication device that can be used to remotely control an AUV even after it is submerged. The AUVs and ASV are guided so that the AUV is always within a certain range directly under the ASV so that they can stay within communication range. In underwater acoustic communication, it may not get through depending on the environment, so a new underwater acoustic message communication technology was developed to enhance communication stability by transferring communication from the AUV that receives the message, to other AUVs.

■ Achievements and developments

The Shell Ocean Discovery XPRIZE, the first-ever international competition for unmanned underwater research, held from 2016 to

2019, of the 32 entries from around the world, Team KUROSHIO was the only team from Asia to compete in the finals held in December 2018 off the coast of Greece on the seafloor of the Mediterranean. The AUV towed by the ASV was detached offshore, and spent over 23 hours conducting seafloor research. 30km offshore from the port, in water about 1,000m deep, the survey succeeded in producing a topographic map of the seafloor covering an area of 5km by 33.5km. As a result of the evaluation by the judging panel, Team KUROSHIO was awarded second place (The Grand Prize Runner-Up). This achievement demonstrated to the world the high level of Japan's marine robotics technology and was widely reported in Japan and abroad. This system developed by Team KUROSHIO has the potential to respond to national-level issues such as seafloor topography surveys, but also to private sector needs such as searching for lost objects, and installing and maintaining equipment installed offshore, under the sea, or on the seafloor, such as submarine cables, offshore wind power generation facilities, and more.



Concept illustration of the offshore and undersea robot system

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