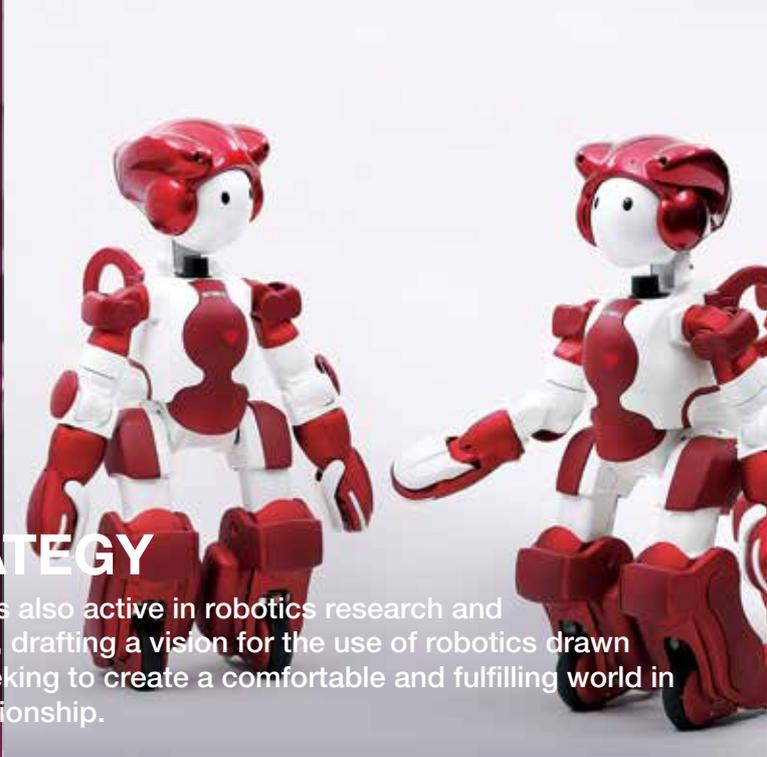


CASE 02 ▶ Robotics

OUR INSIGHT AND STRATEGY

As an Innovation Partner for the IoT Era, Hitachi is also active in robotics research and development—sharing the future with customers, drafting a vision for the use of robotics drawn from projections of ideal future societies, and seeking to create a comfortable and fulfilling world in which humans and robots enjoy a symbiotic relationship.



Robotics Solutions for the IoT Era

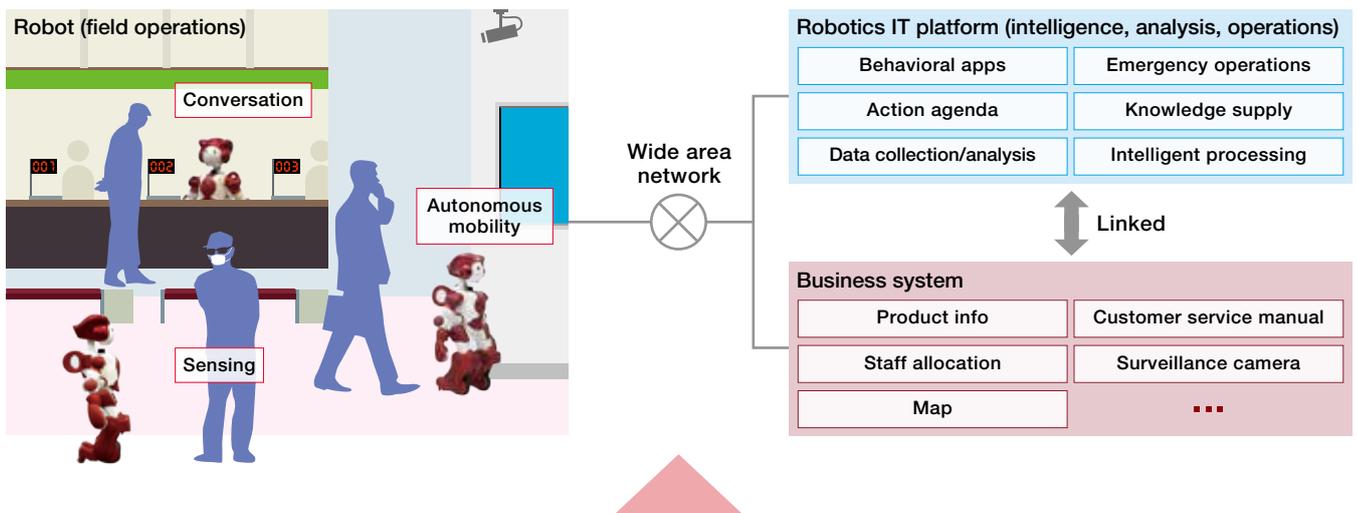
Robots raise quality of life and contribute to efficiency and safety improvements not just in manufacturing but throughout our daily lives by performing tasks that are difficult for humans and compensating for labor shortages. In the future, robots are expected to be able to connect with each other to gather necessary information, learn for themselves, and work in an ever-broadening range of fields.

Since unveiling a computer-controlled, artificially intelligent robot in 1970, Hitachi has integrated the fruits of its ongoing technical research and development in this field into a wide variety of products. In the 1980s, we helped drive adoption of industrial robots, pioneering technical developments as part of a national project. In the 1990s,

our attention turned to the practical applications of robotics, with development focused on how robots could play a role in the community, including the fields of public services, medicine, and welfare. Since the turn of the century, Hitachi has concentrated its efforts on humanoid robots like EMIEW that are specifically designed for symbiotic coexistence with humans.

Going forward, Hitachi will continue to draw on its long-cultivated robotics technology and experience as it puts the Lumada IoT platform to work in a wide variety of fields, collaboratively creating with customers new businesses, societies, and lifestyles in which humans and robots can symbiotically coexist.

Overview of EMIEW3 and Hitachi's robotics IT platform



The left side of the diagram depicts on-site locations, such as public facilities and stores. The right side depicts the computing environment. The robotics IT platform (top right), responsible for the robot's intelligence processing and operational control, is linked to business systems (bottom right) and controls multiple EMIEW3s installed on-site and connected via the network. Receiving instructions from the robotics IT platform, each EMIEW3 can perform a variety of services, such as interacting with and guiding customers. Information recognized by an EMIEW3 through its various sensors is sent to the robotics IT platform, where it is stored and used to improve the precision of EMIEW3 operations.

# OUR ACHIEVEMENTS

Hitachi's latest robotics technology addresses the needs of today's society and aims at a symbiotic coexistence of humans and robots.

## EMIEW3: The Humanoid Robot

Hitachi has long promoted the development of robots that coexist symbiotically with humans, aiming to create robot services with rich communicative abilities that can safely and symbiotically coexist with humans.

Unveiled in 2016, EMIEW3 agglomerates Hitachi's decades of knowledge and experience into a robot featuring high levels of both information processing and autonomy. The robotics IT platform, responsible for information processing and control of the robot itself, is located in the cloud. It connects to the robot in real time, enabling it to perform advanced support services like interacting with and guiding customers. EMIEW3 can identify customers in need of support and approach them on its own initiative, share information with other EMIEW3 units, and hand off service tasks to other parties when necessary. EMIEW3 is equipped with a function to regain a standing position by itself in the unlikely event that it should fall over.

Hitachi aims to use EMIEW3 for guidance services in airports, train stations, and other situations that may require

multilingual support and autonomous operation, as well as in banks and commercial facilities that handle multiple complex services in a single branch. Through field trials at airports, train stations, and commercial facilities, we will continue collaborating with customers to create new practical applications for EMIEW3.

"EMIEW" stands for "Excellent Mobility and Interactive Existence as Workmate," directly reflecting Hitachi's goal of a robot that can exist in symbiosis with humans, moving fluidly and communicating through speech.

EMIEW2, announced in 2007, was able to move at the pace of a fast-walking human, and combined a number of functions to allow it to interact and guide customers, such as autonomous movement, the ability to detect human voices in noisy environments, functions to recognize objects based on data on the internet, and the ability to search for objects using multiple networked cameras within a facility as "eyes." EMIEW3 inherits the best of EMIEW2's abilities while adding new functionality of its own, and its announcement in 2016 is another milestone in robot evolution toward symbiotic coexistence with their human creators.

## PMORPH2: A Robot to Investigate Fukushima Daiichi



Hitachi-GE Nuclear Energy, Ltd. (Hitachi-GE) is working toward the decommissioning of Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station. Since joining the International Research Institute for Nuclear Decommissioning (IRID), founded in 2013 with the aim of developing the necessary technology for this unprecedentedly difficult decommissioning project, Hitachi-GE has advanced its research and development efforts toward this goal.

In March 2017, PMORPH2—a robot to investigate the basement floor inside the Unit 1 Primary Containment Vessel (PCV) developed by Hitachi-GE in its role as a member of

IRID—was sent into the Fukushima Daiichi Nuclear Power Station Unit 1 PCV to investigate the condition of the fuel debris (melted and fallen nuclear fuel) within the vessel.\* Based on technology developed by the Hitachi Group, PMORPH2 is able to pass through a narrow pipe roughly 10 cm in diameter, and has the unique ability to transform from a straight, thin shape like the letter "I" into the shape of the letter "U" in order to maneuver stably inside the PCV.

The investigation was carried out by taking measurements and photographs at five locations 10 times over five days. Due to sediment inside the PCV, it did not succeed in photographing the fuel debris itself, but the range of data it obtained will be used in future explorations of methods for removing the fuel debris.

\* PMORPH2 was developed with the Subsidy Project of Decommissioning and Contaminated Water Management by Ministry of Economy, Trade, and Industry (METI).

## Hitachi-GE Nuclear Energy, Ltd.

**Satoshi Okada, PhD**

Senior Engineer, Nuclear Equipment Design Department, Nuclear Engineering and Product Division

In highly radioactive areas, electronics are of limited use. As a result, when using a robot to investigate the PCV interior, the skill of the operator is also a vital element. The key to a successful probe is harmonious teamwork between human and robot. The road to decommissioning is daunting, but this investigation result has allowed us to take another step toward that goal. At Hitachi-GE, developers do not just improve by sharing and discussing ideas internally—they also collect information from around the world to use when developing new technology.

