Case Study

Intel® Core™ Processor
Intel® RealSense™ Depth Camera

Autonomous Mobile Robots at Work in Nippon Express Logistics Center More Effective Picking Work, Rapid Innovation

Seeking to enhance the efficiency of picking work in its Heiwajima Logistics Center, Nippon Express has adopted the rapyuta.io crowd robotics platform developed by Rapyuta Robotics along with 15 of the company's Rapyuta PA-AMR picking assist robots. Rapyuta PA-AMR is equipped with an Intel® Core™ i5-8365UE processor implementing ROS and two Intel® RealSense™ D435i Depth Cameras for SLAM and obstacle detection and avoidance.

Company name: Nippon Express Co., Ltd.

Address: 2 Kandaizumicho, Chiyoda-ku, Tokyo 101-8647, Japan

Areas of operation: Distribution business overall and related businesses such as vehicle transportation; rail freight forwarding; marine transportation; coastal shipping; air freight forwarding; warehousing; travel; customs-clearance; transportation, construction, and installation of heavy goods; special transportation; information processing and analysis, etc.

https://www.nittsu.co.jp/

Company name: Rapyuta Robotics

Address: 4-10-5 Hirano, Koto-ku, Tokyo 135-0023, Japan

Areas of operation: Cloud robotics platforms and provision of collaborative picking assist robots

https://www.rapyuta-robotics.com/

Rapyuta Robotics
Project Manager
Kazuhiro Aizawa

15 AMRs support picking work at the logistics center of Nippon Express

At the Heiwajima Logistics Center of Nippon Express in Ota Ward, Tokyo, 15 Autonomous Mobile Robots (AMRs) are at work along with around ten other staff (Figure 1).

Staff in charge of picking take parts from shelves according to instructions on screens at the top of the robots and use a reader on the side of the display to read barcodes then place the parts on the robot's container. When finished picking from one shelf, the staff worker moves to the next location shown on the robot's screen to repeat the same process. Sometimes the same robot arrives to continue with the same batch, sometimes another robot will come for picking work on a different batch. Robots that have gathered all the indicated parts automatically move to the unloading area.

This logistics center stores and delivers service parts for major air conditioning manufacturers, handling 1,500 to 2,000 shipment requests per month at normal times. But this number triples during the peak period from June to September, requiring extra personnel, which can be hard to secure with the labor shortages of recent times. Not only that, the process whereby staff gather the required parts by going back and forth between shelves while pushing a cart and holding a paper picking sheet and handy terminal cannot really be described as efficient. They also have to travel to and from the unloading area, for a total distance of several or even ten or more kilometers per day, a physically demanding effort.

To counter this, Nippon Express has adopted a system comprised of the rapyuta.io cloud robotics platform developed by Rapyuta Robotics, along with Rapyuta PA-AMR picking assist robots[1].

Figure 1 Rapyuta PA-AMR collaborative picking assist robot of Rapyuta Robotics operating in the Heiwajima Logistics Center of Nippon Express (provided by Rapyuta Robotics)

Kazuhiro Aizawa of Rapyuta Robotics describes the situation as follows. "There are two main reasons why Nippon Express took an interest in our technology. Firstly, the rapyuta.io platform has the potential to connect with other types of robots and material handling devices other than AMRs in the future. Secondly, Rapyuta PA-AMR is a solution that works effectively with people, so that it can bring greater efficiency while maintaining the accumulated knowhow of frontline workers. We're more than happy to have a major 3PL like Nippon Express become our first user."

The rapyuta.io platform realizes cloud robotics architecture

Rapyuta Robotics was founded in Japan in 2014 as a spin-off from the European RoboEarth[2] research project.

It provides the rapyuta.io cloud robotics platform, which is a Platform as a Service (PaaS) based on Rapyuta, the outcome of the RoboEarth project. Robotic clones configured in the cloud communicate together in a system realizing coordinated (group) control for robots.

The actual system centers on rapyuta.io and consists of a warehouse control system that handles interfacing with the client warehouse management system (WMS), optimum allocation of task instructions to the robots, and functions such as route planning and navigation (Figure 3). Task instruction allocation, route planning, and navigation can be implemented at the edge (Edge in Figure 3) rather than the cloud.

Maps necessary to control the robots are generated from sensing data such as RGB+D sent from the robots (AMRs in this case). One feature of rapyuta.io is to merge map data from several robots for greater accuracy.

Rapyuta PA-AMR employs the Intel® RealSense™ Depth Camera to sense its surrounding environment

Rapyuta PA-AMR, shown in Figure 1, is an autonomous mobile robot developed by Rapyuta Robotics as a means to realize rapyuta.io. The body size is 600 mm wide x 600 mm long (and 1350 mm high) to fit in standard Japanese aisles. It can carry a maximum load of 45 kilograms.

Its internal equipment centers on a computer with an Intel® Core™ i5-8365UE processor to control the robot, a depth camera and 2D LiDAR to detect surrounding people and obstacles, a touchscreen display, barcode reader, Wi-Fi connectivity, battery and battery control circuit, drive motor, two emergency stop buttons, a speaker, and a running light.

Rapyuta PA-AMR is a type of so-called "cobot" (collaborative robot) that is active in the same space as humans, requiring various safety measures to prevent it from causing harm or damage to the people and objects around it. It also needs to sense its surrounding environment for Simultaneous Localization and Mapping (SLAM) to create a map for self-positioning.

PA-AMR has two depth cameras located in front at the top and bottom, and is equipped with two 2D LiDAR units at its front and rear. "Staff sometimes work inside the warehouse, pushing carts as they move. We gave careful thought to combining depth cameras and 2D LiDAR together and how to locate them to prevent blind spots under any conditions." (Aizawa)

The depth cameras used are Intel® RealSense™ D435i depth cameras (Figure 4). Aizawa explains the reasons for this as follows. "They provide a superb balance of size, pricing, and performance compared to solutions from other companies, on top of which the camera itself calculates the depth data, saving processor resources."

Figure 2. The rapyuta.io cloud robotics platform achieves group control of multiple robots (provided by Rapyuta Robotics)

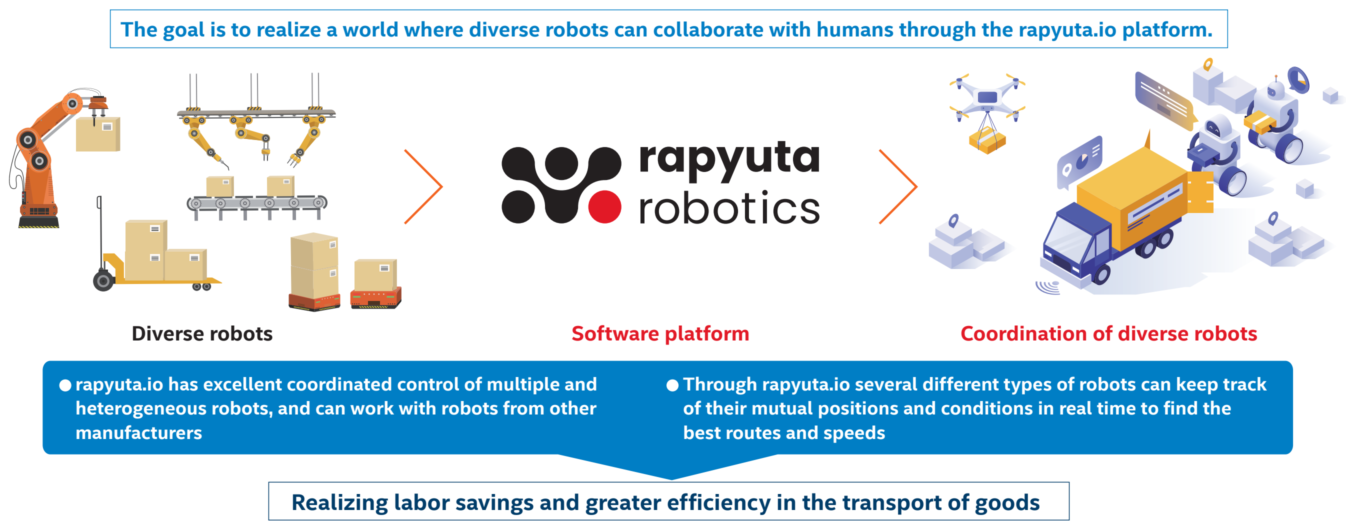


Figure 3. Overall architectural concept including rapyuta.io (provided by Rapyuta Robotics)

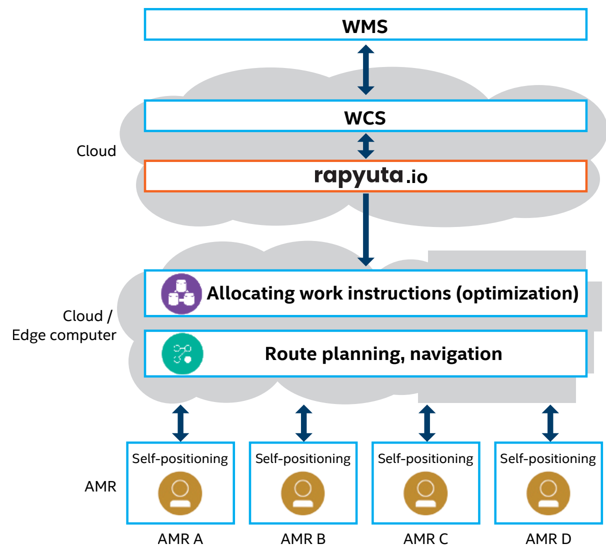
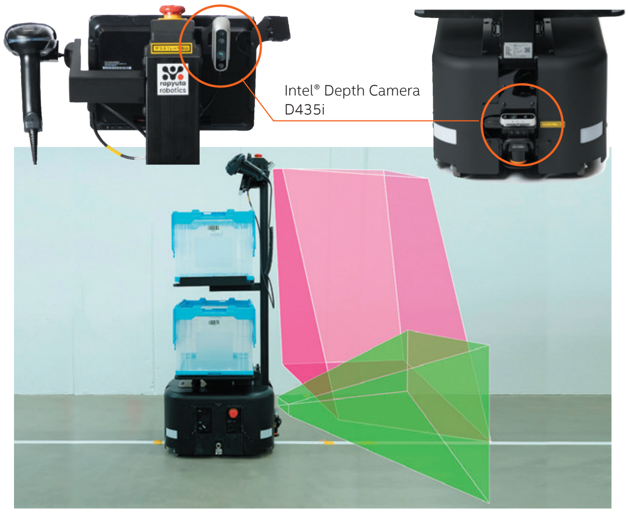


Figure 4. Illustration showing the Intel® RealSense™ Depth Camera D435i mounted on the Rapyuta PA-AMR and its range for detecting people and obstacles in front of it and for SLAM (provided by Rapyuta Robotics)



He also said that another reason to choose them was the full development environment of the software. "In addition to providing the ROS-compliant Intel® RealSense™ SDK 2.0, there is also a highly active community. Many of our employees are committed to open source communities. They often help us to find solutions when something comes up. That was a key point we took into account." (Aizawa)

rapyuta.io creates a map based on the RGB+D data from the Intel® RealSense™ D435i Depth Camera and the rotation angles from the 2D LiDAR, while the Intel® Core™ i5-8365UE processor in Rapyuta PA-AMR handles self-positioning and avoidance of people and obstacles.

Creating an age where people and robots work together to cope with social issues such as a declining workforce

Nippon Express started trials using the Rapyuta Robotics system in June 2019. The main objectives were coordination with its existing WMS and frontline operation tests. A Rapyuta PA-AMR prototype with Intel® NUC was used at this time. Intel® NUC is a compact yet high-performance and versatile PC with an Intel® Core™ processor. It is used for a wide variety of applications in addition to PoC, including education, business, and industry (integration).

The Intel® Core™ processor used in Rapyuta PA-AMR has several advantages such as scalable performance, a broad ecosystem, and abundant development assets, and can be easily shifted from a prototype to an industry-grade commercial machine.

Actual operations started in August 2020 after the above trials, initially with the use of 10 Rapyuta PA-AMRs, which were joined by five more in August 2021.

Several issues were identified during the trials and after the launch of actual operations, such as for route mapping and navigation, each leading to further refinement of rapyuta.io and Rapyuta PA-AMR. As Aizawa puts it, "Nippon Express was our first example, so the input from our client helped us to deal with issues that could only be spotted in real operations." Nippon Express is also working on the optimization of environments to coexist with AMRs.

For example, pairing Rapyuta PA-AMRs with containers in the unloading area meant that a lot of them were left idle, so the company switched to allow pairing when they were in standby locations as well. The high visibility of the user interface was further improved to accommodate client requests. Further improvements in efficiency were confirmed with Nippon Express changing from a total picking method handling several orders in batches to a single order picking system to reduce the walking distance of their staff, and changing procedures to omit sorting in the unloading area.

As a result of adopting rapyuta.io and the Rapyuta PA-AMRs, the stress and workload on staff were decreased, overtime work was scaled back, and concerns over securing personnel during peak times was eliminated, creating opportunities to realize even more efficient workplaces. Plans are being considered to expand the scope to warehousing operations and shelving, and to adapt it to other distribution centers of Nippon Express.

Rapyuta Robotics, on the other hand, is working on projects focusing on distribution and warehouse operators incorporating the knowhow gained with Nippon Express. It has already delivered a total of 25 robots to Sagawa Global Logistics and 20 to Keiyo Distribution Warehouse Inc. The company is also collaborating with other industrial robot manufacturers, including on Good To Person (GTP) types.

"The guiding principle of Rapyuta Robotics is to leave the so-called dirty, dull, and dangerous work up to robots, to provide environments where people can take up more intellectually challenging and creative work. We believe this is the first step toward realizing a society where robots and humans coexist together," says Aizawa.

Rapyuta Robotics was founded in a Japan facing social issues such as an aging population with a low birth rate and labor shortages. Many industries are looking closely at its technologies and initiatives as both a Japanese company and a global company gathering together talented engineers from over 20 countries.

Autonomous mobile robots gather external information via various sensors to determine by themselves what to do. They require sophisticated sensor fusion and AI image processing and high processor performance, yet must run on low power to allow operation by batteries. The Intel® Core™ Processor Family for embedded applications is perfect for this purpose.

Intel is actively investing in the "Four Superpowers of innovation": ubiquitous compute, cloud-to-edge infrastructure, pervasive connectivity, and Artificial Intelligence. Robots will support further technological innovation by putting these Four Superpowers to use for a comprehensive technological approach from the edge to the cloud.

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REALSENSE™

Intel® RealSense™ Technology Provides Eyes for Robots

The Intel® RealSense™ Depth Camera is a 3D sensor device that uses a stereo camera to acquire depth information. With a built-in Intel® RealSense™ Vision Processor D4, it can output depth data showing the distance to objects and IR image data in addition to RGB image data.

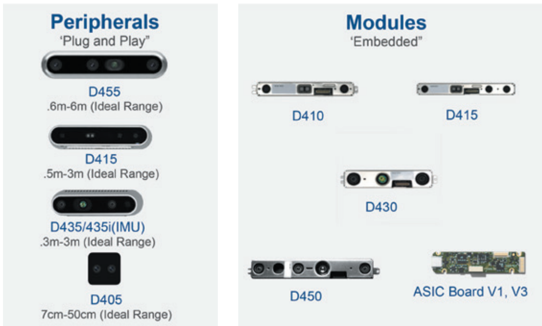
Intel® RealSense™ SDK 2.0 is integrated with an open source library as the development environment, which supports libraries for peripheral segmentation, and 3D scanning. It also supports a community.

Because it is ROS compliant, it is used in many robots and drones for purposes like peripheral recognition, SLAM, and obstacle avoidance.

The Intel® RealSense™ Depth Camera D435i built into Rapyuta Robotics' Rapyuta PA-AMR has specifications for optimal ranging of 0.3 to 3 meters, a 87°×58° field of view, depth accuracy of 2% or less at two meters, maximum depth resolution of 1280 x 720 at 30 fps, and maximum RGB resolution of 1280 x 720 at 30 fps. It is 90 mm wide x 23 mm long and 20 mm high, with a built-in inertial measurement unit (IMU) and a USB-C 3.1 Gen 1 external interface.

Intel® RealSense™ Technology acquires depth information via the stereo camera

Examples of a depth map (left) and RGB image showing the distance to the object



1. https://www.rapyuta-robotics.com/ja/case-nittsu/
2. http://roboearth.ethz.ch/
* This white paper is based on information as of June 2022.

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