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# News Release

## Multiple AI coordination control that realizes efficient warehouse picking by integrating control of robotic arms with AGV

*Reduced operation time by 38% through coordinated continuous operation*

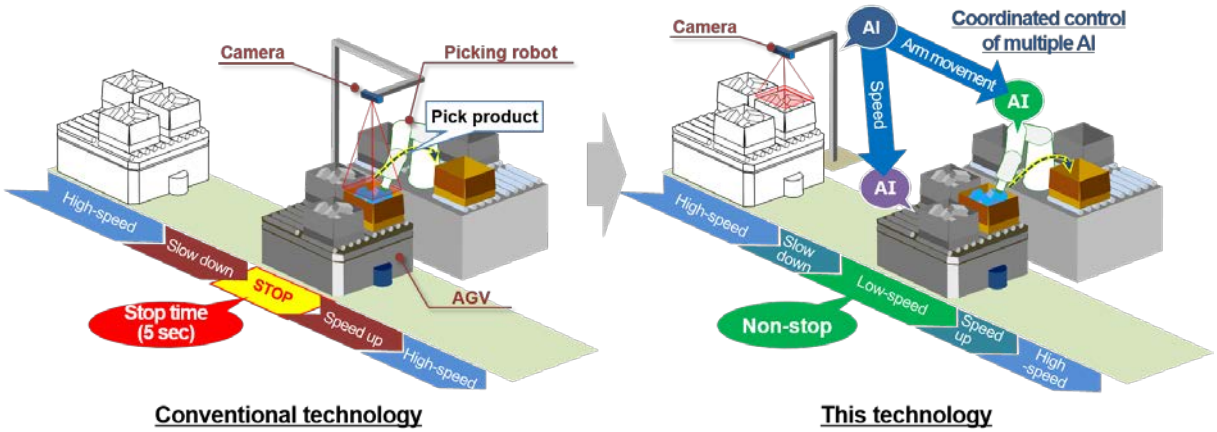


Figure 1. Comparison of technology to remove products from an AGV using a picking robot

Tokyo, May 28, 2018 --- Hitachi, Ltd. (TSE: 6501, Hitachi) today announced the development of multiple AI coordination control technology that increases the efficiency of the picking process by integrating the control of the picking robot*1 and automated guided vehicle (AGV)*2 to smoothly pick-up specific products from goods carried by the AGV. The new technology coordinates control by integrated management of the AIs that control the picking robot and the AGV, based on decisions made by the AI that determines the optimal picking method for specified products from camera*3 images. The AGV and robot arm can move closer to each other at optimal speeds to avoid collision based on the state of the goods stacked on the AGV, enabling smooth picking by the robot arm without stopping the AGV (Figure 1). The results of a comparative experiment using conventional technology where the AGV is stopped each time for picking, confirmed that the time required for picking could be reduced by 38% with the new technology. Hitachi will work towards the commercialization of a robot system for warehouse operations as well as contribute to increased efficiency in logistics through development of technology to increase the speed and automation of processes. The design of the trajectory planning and fine adjustment function for the robotic arm, necessary for this technology, was developed in collaboration with the University of Edinburgh, U.K.

In recent years, greater efficiency and automation in warehouse operations are in demand as they face a dramatic increase in picking operations that require specific orders to be selected from a vast range and large number of stock. AGV that carry

products by case or by shelf have already been commercialized to support picking operations, and currently development of systems which combine the operation of AGV and picking robots that remove products from cases, is underway. The challenge however is that it is difficult to instantaneously determine the best way to pick up a specific product and control the picking robot while taking into consideration the speed of the AGV as goods in the cart become disarrayed during picking and transport. Thus, it was necessary to stop the AGV before starting picking operations resulting in a time loss while the AGV is stopped which added to the difficulty of establishing more efficient systems. To address this challenge, Hitachi developed the multiple AI coordination control technology to optimize the efficiency of the picking process by coordinating the picking robot and the AGV.

Features of the technology are as follows:

**(1) AI determining the optimal picking method from camera images**

AI was developed that determines from camera images, the position of a product which can be picked by a picking robot from how goods are stacked in a case and the speed of the AGV. By inputting 3D data of product to be picked before the operation, the AI simulates several tens of thousands of ways that the robotic arm could pick a product from randomly generated various states of stacked goods transported at various speeds. Based on the results of the simulation, the AI automatically generates image processing analysis training data***4** for deep learning***5** to analyze the information necessary to determine how to control the picking robot and the AGV, that is, determine the position of products which change with the state of how goods are stacked as well as the adjustment required in AGV speed. This system can be implemented and operated efficiently as the AI is not required to learn during the actual picking operation, it can be implemented and operated efficiently.

**(2) Real-time multiple AI coordination control**

Technology was developed to coordinate and control in real-time the AI for the robotic arm as well as the AI for the AGV, based on the AI that determines the optimal picking method from images of goods within cases taken as the AGV approaches the picking robot. This technology instructs the arm movement calculated from the position of the product to be picked to the AI that controls the picking robot, and instructs the AI controlling the AGV to accelerate or decelerate based on current speed. Further, the AI for the picking robot can confirm the speed and the location of the AGV in real time and conducts minor adjustments to prevent the arm from colliding with the case or other products, thus enabling efficient automatic picking as the AGV does not need to be stopped. (Figure 2)

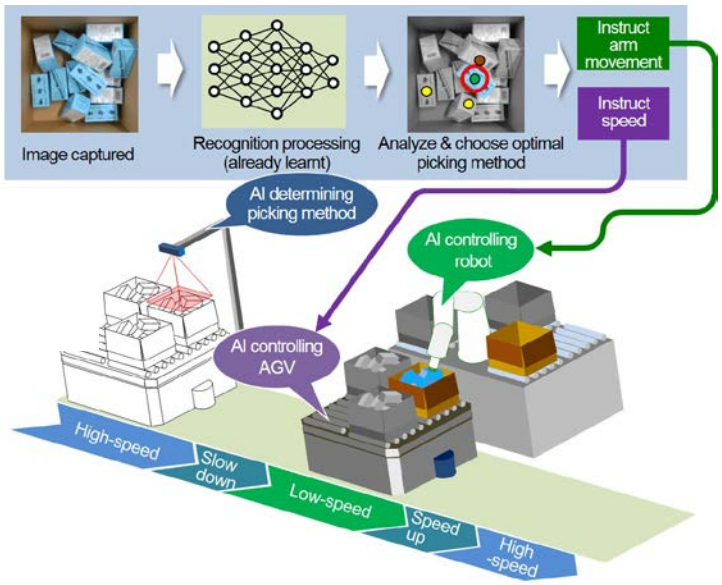


Figure 2. Image of real time processing with multiple AI coordination control technology

An in-house experiment utilizing this technology resulted in successful picking from AGV which moved non-stop at a speed of 0.5 meters per second. Further, it was found that by employing the new technology, the procedure which required 13 seconds with the conventional method of stopping the AGV to pick products, could be achieved in 8 seconds, a 38% improvement in speed.

**Comment from Professor Sethu Vijayakumar FRSE, Personal Chair of Robotics at Edinburgh University and Director of the Edinburgh Centre for Robotics**
"We are delighted to see the successful results of more than two years of collaboration with the Hitachi R&D Group, Center for Technology Innovation, culminating in practical and deployable improvements in automated warehousing technology. Our robotics lab has been at the forefront of machine learning techniques for adaptive motion planning and control of complex multi-DOF robots and this provides an excellent opportunity to see this expertise used to solve real world problems."

Hitachi will continue efforts to contribute increasing logistic efficiency by working towards the commercialization of this technology as well as integrating it into its AGV, Racrew***6** and autonomous moving robot, HiMoveRO***7**, among others.

*1 Picking is the operation of gathering goods and products according to electronic data and instructions such as at distribution warehouses and manufacturing plants, etc.
*2 An automated or automatic guided vehicles (AGV) transports boxes and shelves containing products to specified locations.
*3 A camera which can photograph RGB-D images as each pixel has both information on color (RGB) and distance (depth).
*4 Training data is used to teach machines to output appropriate answers to input data.
*5 Deep learning is a type of machine learning that mimics mechanisms of the brain's neural circuit. It is comprised of three elements: the input layer, hidden layers, and the output layer. By increasing the number of hidden layers, deep learning is capable of expressing complex models relative to conventional machine learning, and has displayed a high recognition rate in fields such as speech recognition, image recognition, etc.
*6 Racrew is a registered trademark of Hitachi, Ltd. in Japan.
http://www.hitachi.com/New/cnews/month/2015/08/150804a.html
*7 HiMoveRO is a registered trademark and product of Hitachi Plant Mechanics Co., Ltd. in Japan.
http://www.hitachi-hpm.co.jp/mechatronics/HiMoveRO/index.html (in Japanese)

**About Hitachi, Ltd.**

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges, combining its operational technology, information technology, and products/systems. The company's consolidated revenues for fiscal 2017 (ended March 31, 2018) totaled 9,368.6 billion yen ($88.4 billion). The Hitachi Group is an innovation partner for the IoT era, and it has approximately 307,000 employees worldwide. Through collaborative creation with customers, Hitachi is deploying Social Innovation Business using digital technologies in a broad range of sectors, including Power/Energy, Industry/Distribution/Water, Urban Development, and Finance/Social Infrastructure/Healthcare. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

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