Intuitive UI for easy robot teaching

Static Environmental Recognition Technology

AR Initial Alignment Technology Using Edges

Performance profile linkage control technology

Fast Visual Feedback (VFB) Correction

Noise Resistant Speech Recognition Technology

Automatic Generation of Optimal Path

ROS-Edgecross Integration Platform

Optimization of Operation Time Considering Constraints

Recognition for Object with Irregular Shapes Using AI

Intent Understanding Technology for Instruction in Natural Words

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ROS-Edgecross Integration Demo

Automatic Adjustment of Timing to Grip

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Intuitive UI for easy robot teaching

Features

Tablet touch and voice manipuration realize easy robot teaching.

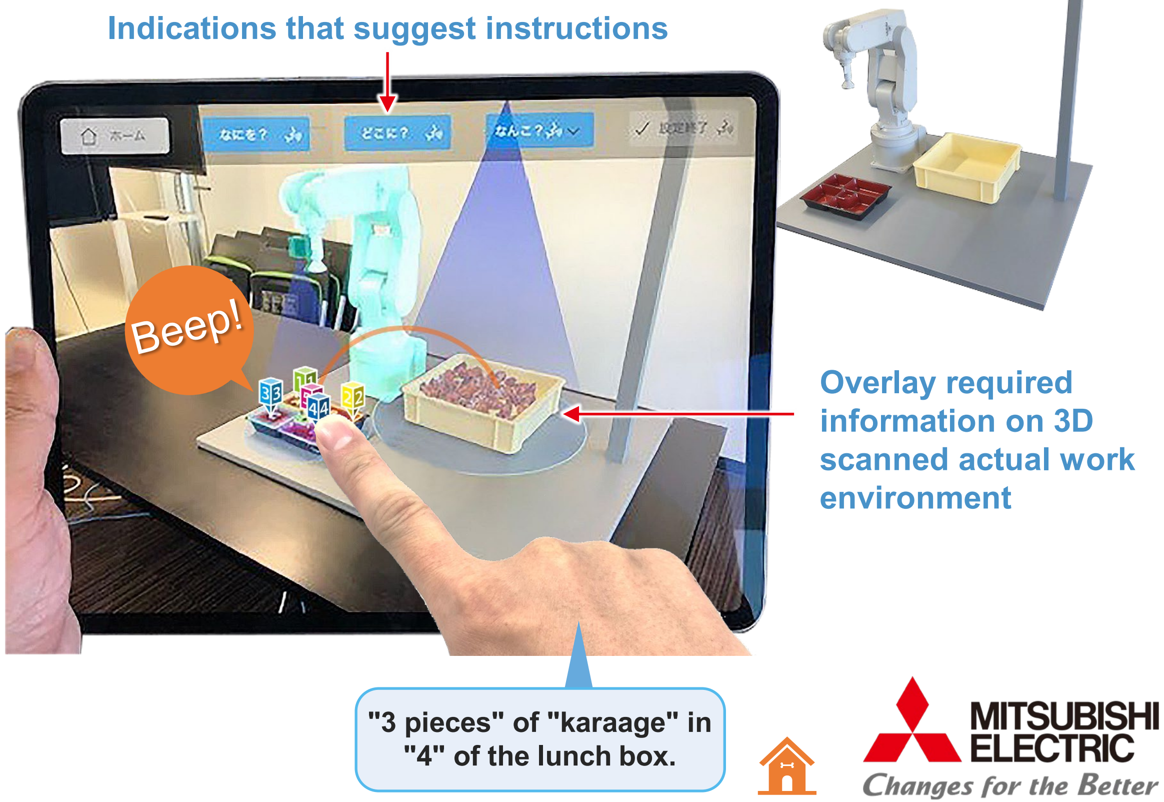
The work environment can be 3D, and various specifications such as the size and position of the robot can be confirmed beforehand by AR.

Operator’s safety is ensured because the robot's movement can be confirmed on AR after the work order is completed.

ECM：Engineering Chain Management
SCM：Supply Chain Management

Diagrams

Easy touch and voice UI



Intuitive UI for easy robot teaching

Reference Exhibition

Features

Robot teaching by touch manipulation

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Intuitive UI for easy robot teaching

Reference Exhibition

Features

Robot teaching by voice manipulation

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Noise Resistant Speech Recognition Technology

Features

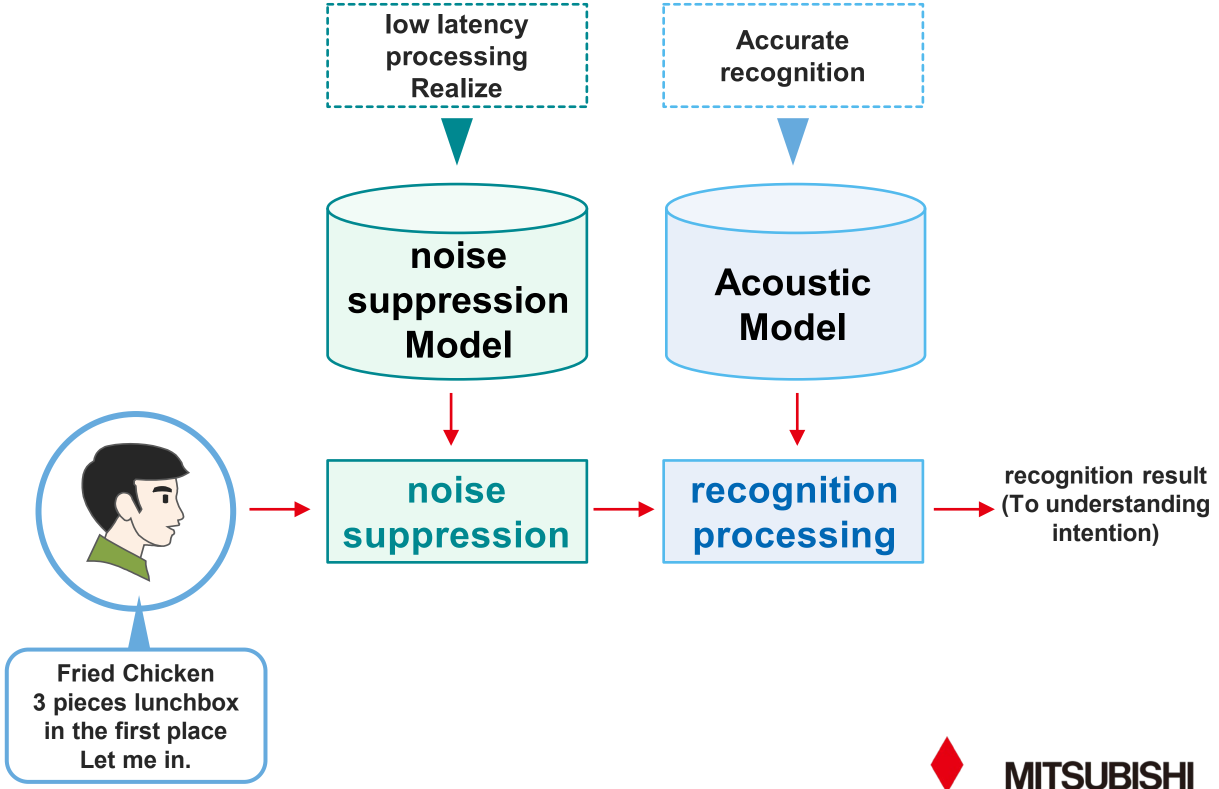
Proprietary AI technology effectively suppresses noise such as robot operation noise with low latency (0.2 seconds)

Realization of low latency and high accuracy recognition by combined use of acoustic model considering noise suppression
(Recognition rate improved from 68% to 95%)

Maisart * technology realizes high-precision recognition and miniaturization that can be worked on edge devices such as tablets.

*Maisart: Mitsubishi Electric's AI creates the State-of-the-ART in technology

Diagrams



Intent Understanding Technology for Instruction in Natural Words

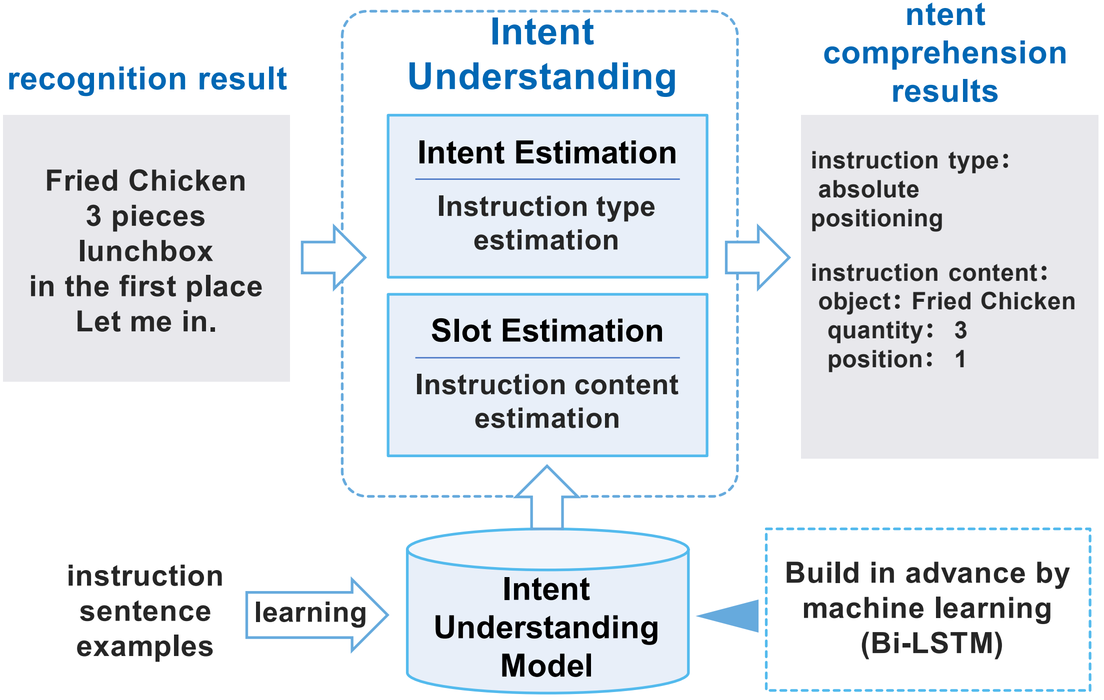
Features

Simple instruction to the robot in natural words input

Accurate Estimation with Intent Understanding Models (Estimation accuracy: instruction type 96%, instruction content 94%)

Relative positioning such as "right of cabbage" and ambiguous positioning such as "slightly above" are also possible.

Diagrams



Static Environmental Recognition Technology

Features

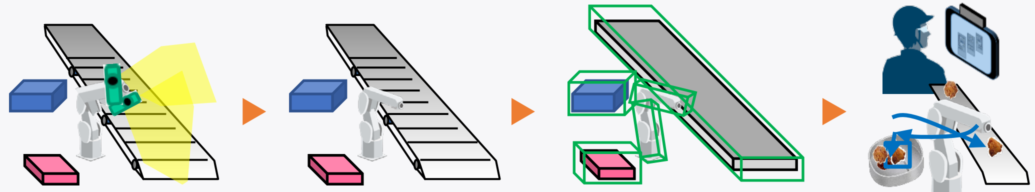
A 3D model of the robot's surroundings can be generated using only inexpensive cameras.

Can be used for interference detection during path generation and displayed on the operation teaching device

Reduced processing by simplifying 3D models and reducing data size (approximately 60% reduction)

Outlines

Static environment recognition and data usage



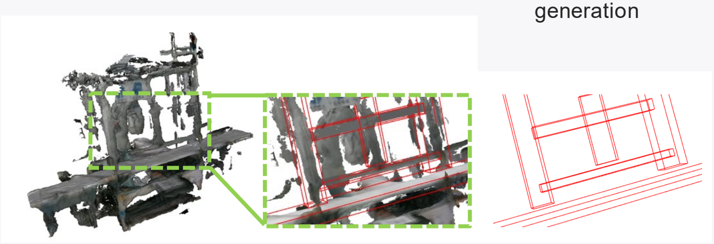
Scanning of surroundings
Images, depth, camera poses can be measured or estimated by SLAM (#1

3-dimension modeling
3D point clouds and polygons can be generated from colors, depth and camera poses

Data size reduction
Approximation to a similar shape and noise removal

Data transmission
Data for display on operation teaching device,interference detection during path generation

Examples of sensors
Intel(R) realsenese D455



※1：Simultaneous Localization and Mapping,
concurrency of Self-Position Estimation and Mapping

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Static Environmental Recognition Technology

Features

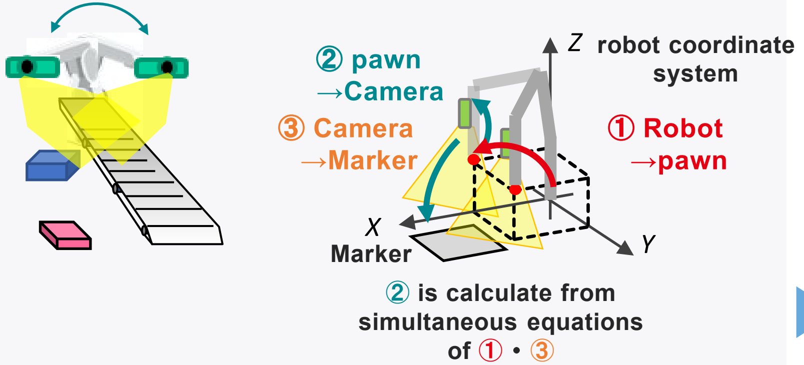
Wherever model is scanned, generated model's coordinates can be matched to robot's coordinates.

By scanning using camera attached to the robot arm, data acquisition process can be automated.

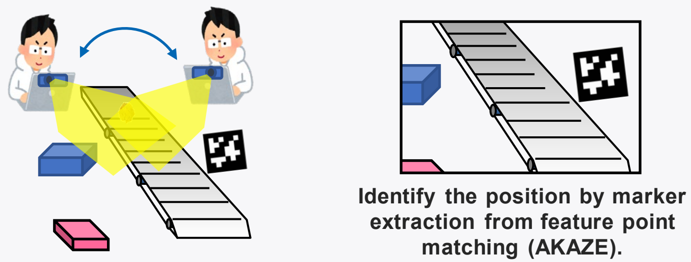
It is also possible to scan manually in narrow place.

Outlines

Scanning by camera attached to the robot



Scanning by moving the camera manually



Positioning is possible with robots and AR space

Data can be transferred to robot and operation device.

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Automatic Generation of Optimal Path

Reference Exhibition

Features

Automatic generation of optimal path without interfering to peripheral equipment by simply specifying start and end points.

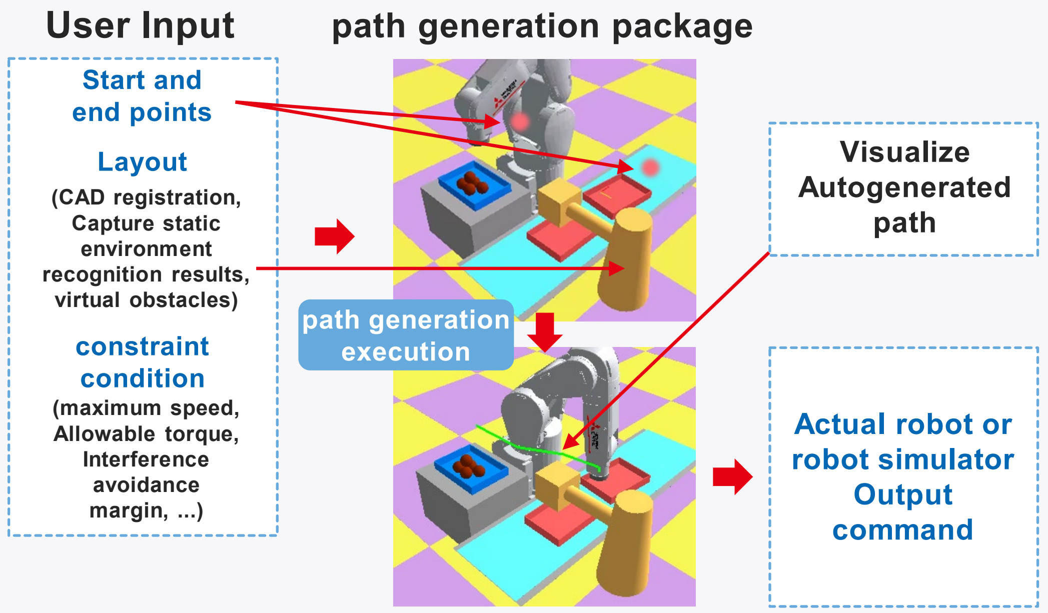
Derive the avoidance route that minimizes the operating time by considering the amount of movement of each joint and the allowable torque*1

No trial and error required for each operation waypoint.
Immediate operation can be possible after relayout.

*1. Patent application pending

Image

Overview of the Path Generation Process



Automatic Generation of Optimal Path

Reference Exhibition

Features

Search a non-interfering path between specified two points according to data of the peripheral equipment.

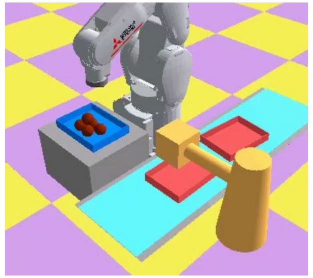
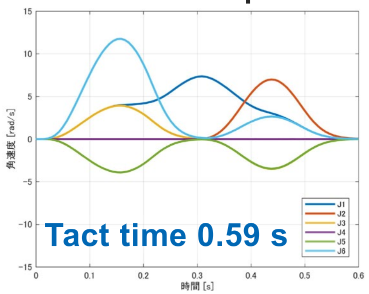
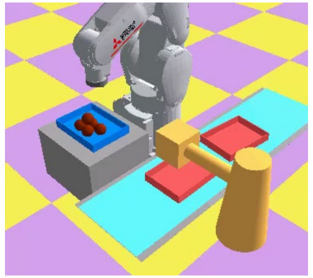
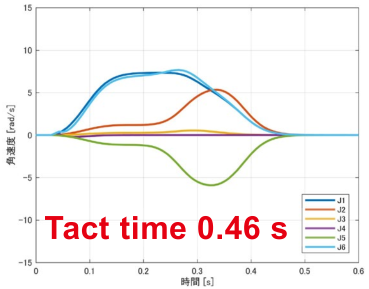
Calculate non-interfering path that the maximum displacement axis can maintain the maximum speed under constraints of speed and allowable torque.*[1]

Achieves tact advantageous motion compared to the motion by trial-and-error of human.

*1. Patent application pending

Image

Verification Example: Path generation without Interfering with Peripheral Equipment in Food Cell

	Hand Tracks (Video)	each axial speed
Human-adjusted path Adjustment time: about 10 minutes Adjustment is difficult to shorten the tact with avoiding interference		
Autogenerated path Search time: 1 second or less Speed of the maximum displacement axis is not slow down and tact shortened		

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AR Collision Detection Technology for Validating the Robot Movement

Features

The movement of the robot can be visually validated by AR, and the collision with the physical environment is also displayed as a warning by AR.

Development of high-precision automatic AR initial alignment method utilizing edge shape.

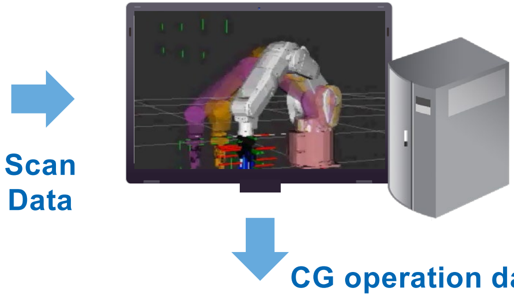
Realizing more real-time operation by markerless method.
Collision with physical objects can be detected.

*ROS: Robot Operating System
*LiDAR: Light Detection And Ranging

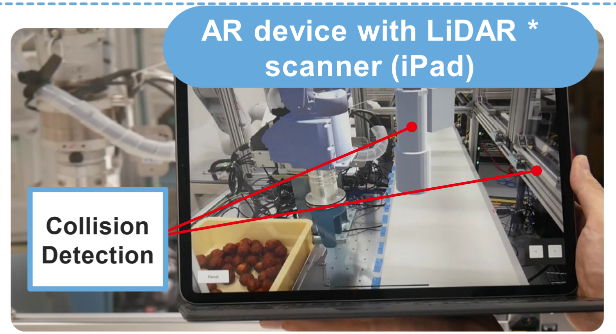
Image

Initial Alignment Scan

Robot motion calculation PC (ROS *)



- ROS calculates robot motion, displays it on AR device
- Collision range warning in red
- Update Collision Results with LiDAR Scans at Any Time



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AR Initial Alignment Technology Using Edges

Reference Exhibition

Features

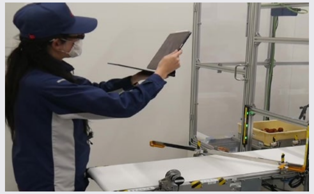
Improved the existing two-step initial alignment method for validating the robot movement in the factory.

Developing Highly accurate global alignment method using the edge of the belt conveyor as features.

Achieving more than 5 times higher accuracy than the existing two-step method (error is a few centimeters)

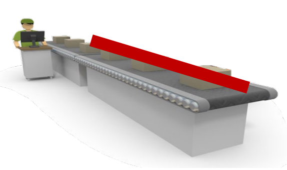
Image

Markerless Scan



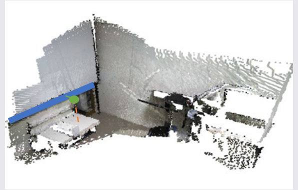
Tap the location near the robot

Global alignment using edges



Get a long edge near the tap position on the device

Local Alignment



Local alignment using existing methods

Achieving high accuracy by combining edge detection with the existing two-step alignment method

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ROS-Edgecross Integration Platform

Reference Exhibition

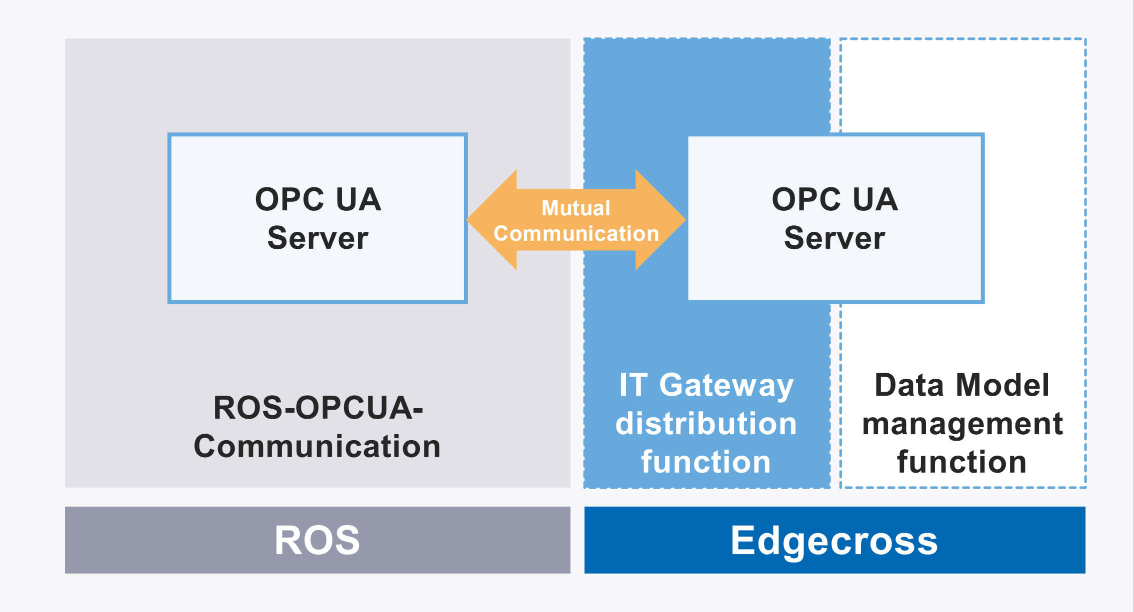
Features

Realizes information integration via OPC UA communication, which is a standard compatible with both ROS and Edgecross.

It is possible to utilize the measured values of non-ROS compatible sensors and information from external systems for ROS control.

Line performance evaluation is facilitated by collecting all system logs including ROS with Edgecross.

Diagrams



ROS-Edgecross integration platform concept diagram

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ROS-Edgecross Integration Demo

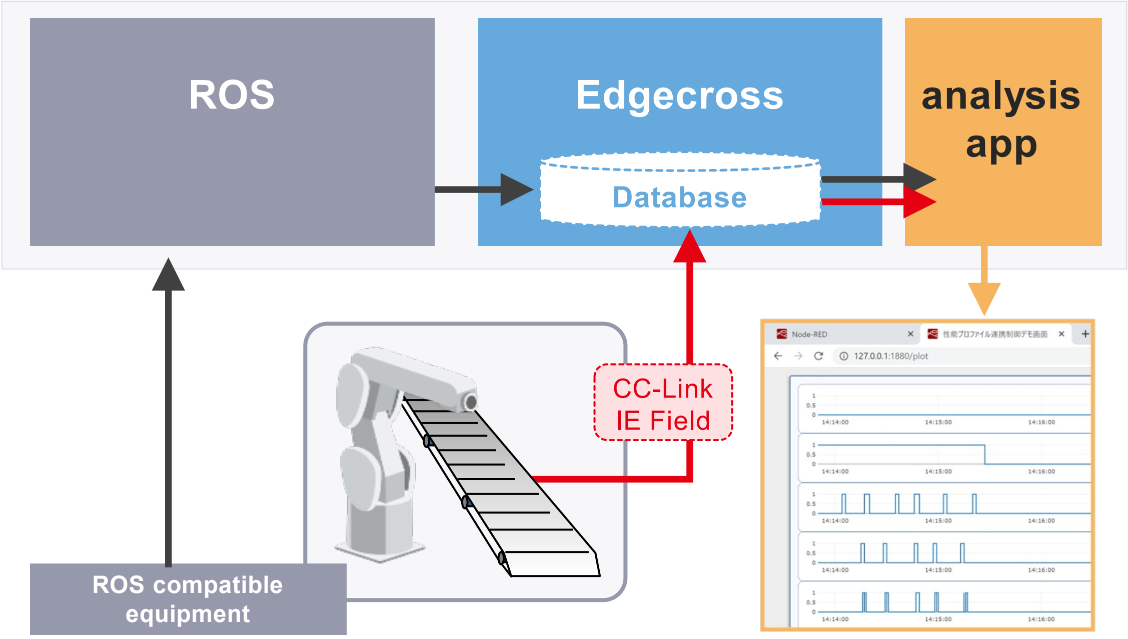
Features

Real-time collection and visualization of various parameters by ROS-Edgecross integration platform

Easy reuse of existing data analysis apps and visualization tools

Unsteady state generated in the robot demo device can be instantly determined and the status can be displayed.

Diagrams



ROS-Edgecross integration demo diagram

Dashboard screen

Performance profile linkage control technology

Reference Exhibition

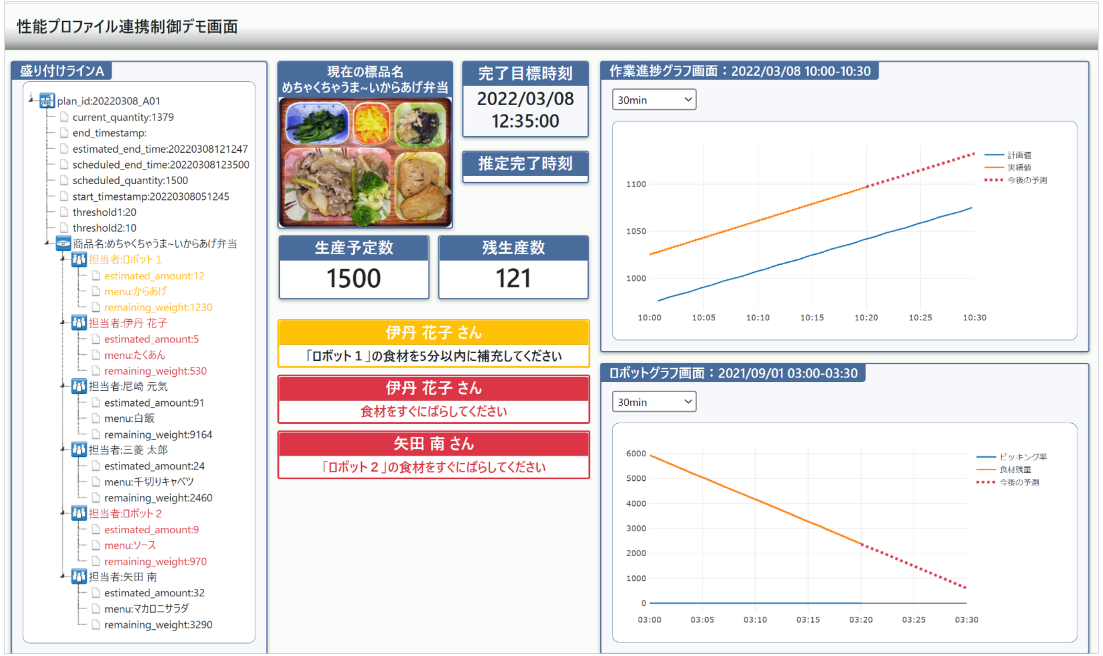
Features

Monitoring performance parameters of line components using Edgecross data model management function

Automatically presents optimal countermeasures based on simulation when performance parameters deteriorate

Rescheduling based on line status is also possible by linking with a production management system

Diagrams



Optimization of Operation Time Considering Constraints

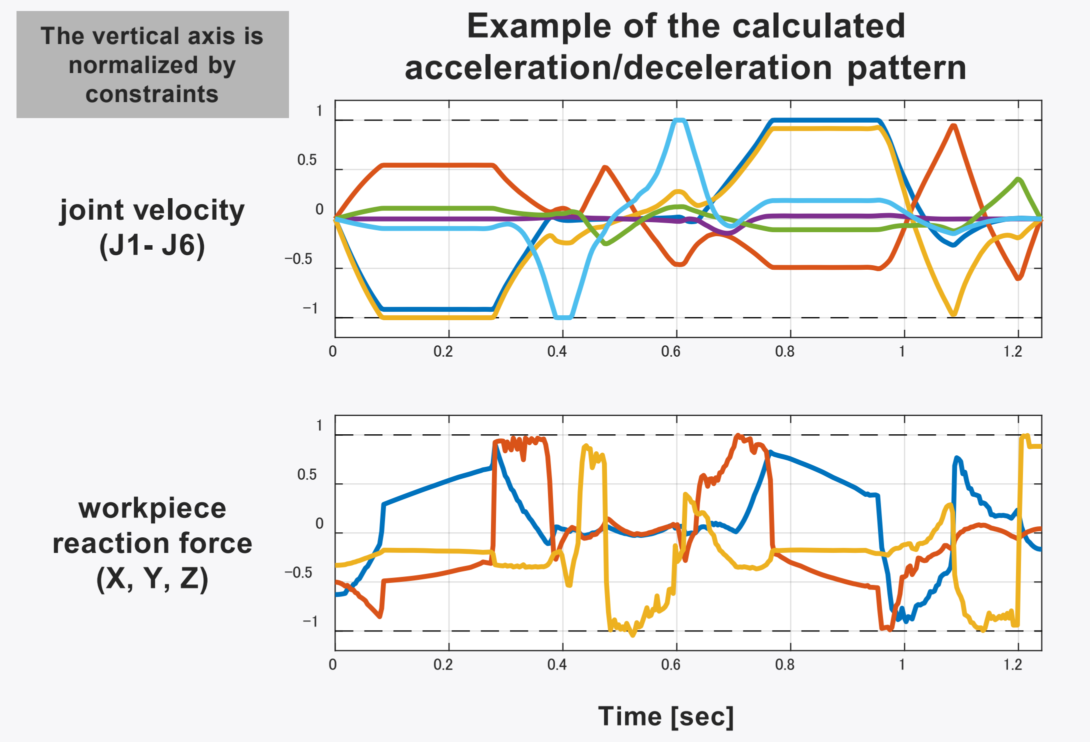
Features

Generate acceleration/deceleration patterns that minimize operating time for a given path.

Constraints on joint speed, acceleration, torque and reaction force applied to the work can be set.

Achieves high-speed and polite food handling in consideration of the reaction force during gripping and transportation.

Diagrams



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Optimization of Operation Time Considering Constraints

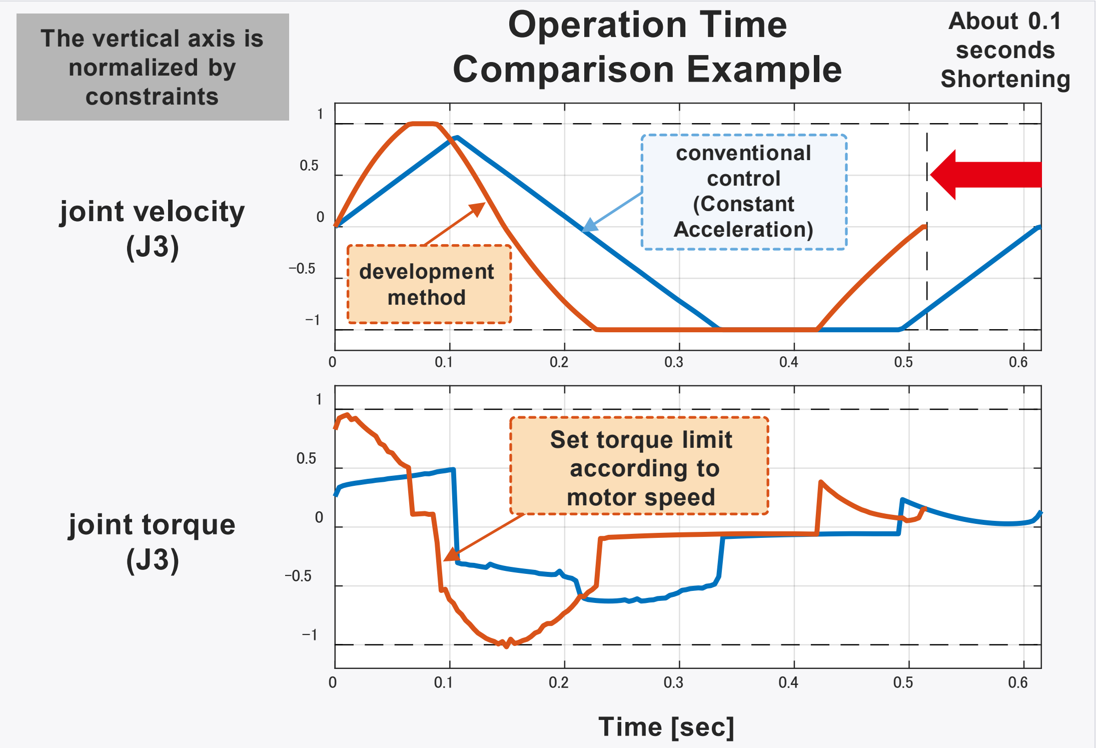
Features

Instantly calculate the optimum acceleration / deceleration pattern even for complicated paths (a few ms on a PC)

Shorter operating time than conventional control by using constraints up to the limit

No need to adjust acceleration/deceleration parameters for each motion

Diagrams



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Automatic Adjustment of Timing to Grip

Reference Exhibition

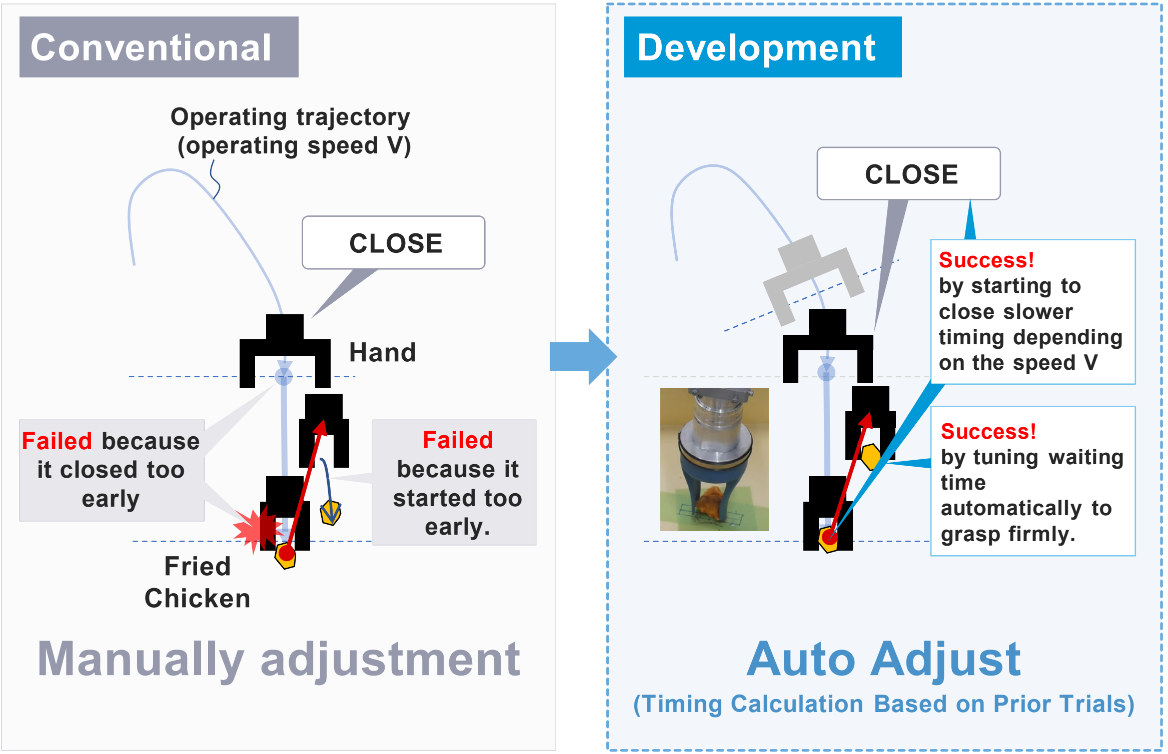
Features

Automatic adjustment of hand grip timing with achiving both high-speed operation with minimum stop and stable grip.

Depending on robot operation speed V, the hand controller automatically changes grip/release timing.

Depending on their softness of objects and fingers,
the hand controller automatically sets the waiting time to grasp objects firmly.

Image



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Automatic Adjustment of Timing to Grip

Reference Exhibition

Features

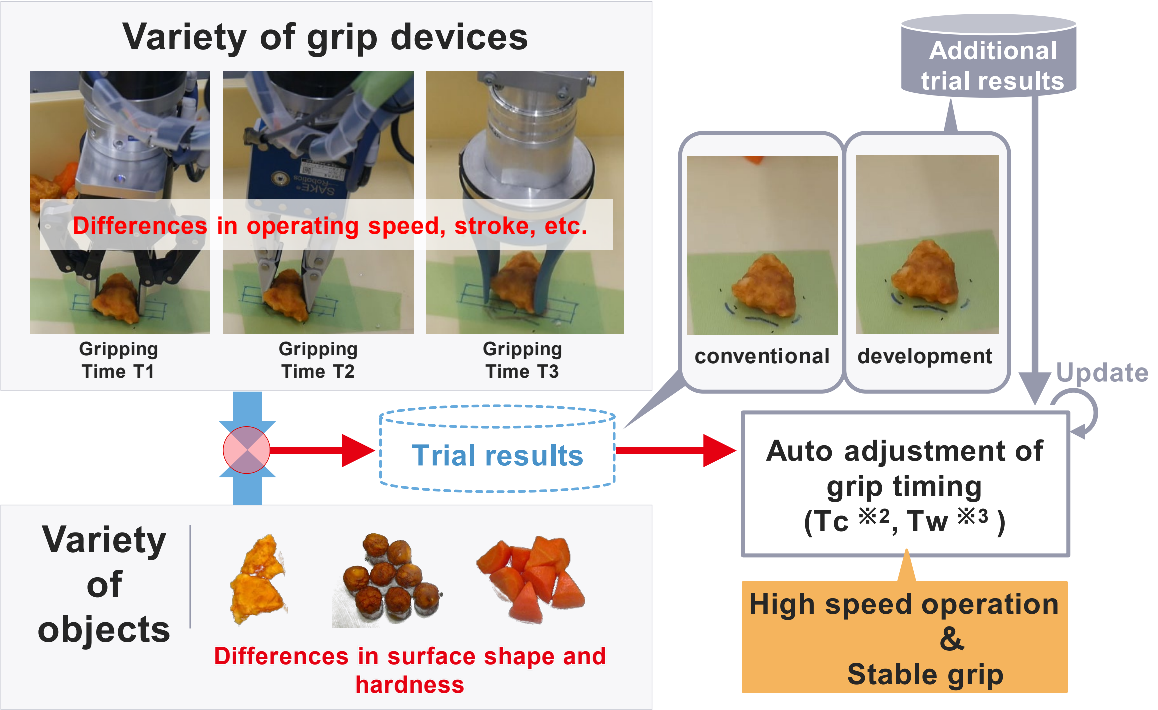
Automatic adjustment of hand grip timing with achiving both high-speed operation with minimum stop and stable grip.

"Minimize stop time" according to its operating speed
(Conventional: 0.3 [s] ⇒ Development: 0.1 [s]*1)

Contributes to shortening on-site adjustment time by adjusting grip timing automatically

*1 Evaluation results of the development system

Image



※2 Tc: start time to close fingers ※3 Tw: waiting time to hold on firmly

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Fast Visual Feedback (VFB) Correction

Reference Exhibition

Features

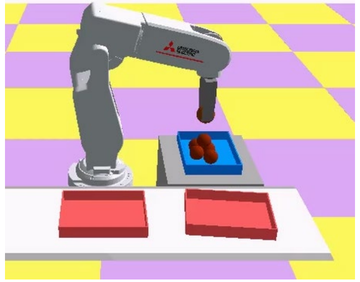
Automatically detect and correct the target position from the camera image installed on the robot's hand

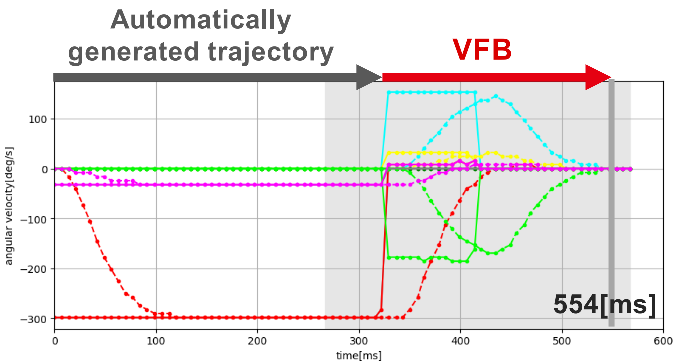
Achieves both high-speed operation and stable work by combining with the trajectory generation function

The operation time is shortened by starting the correction without stopping from the middle of the operation of the automatically generated trajectory.

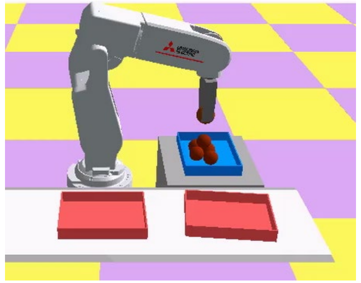
Diagrams

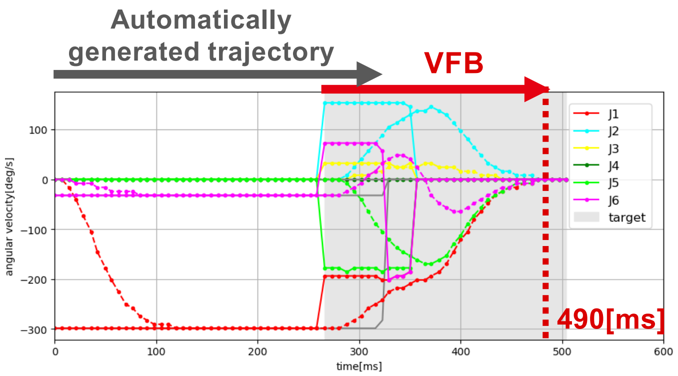
Conventional method
(VFB correction after completion of trajectory)





Development method
(VFB correction during trajectory operation)





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Fast Visual Feedback (VFB) Correction

Reference Exhibition

Features

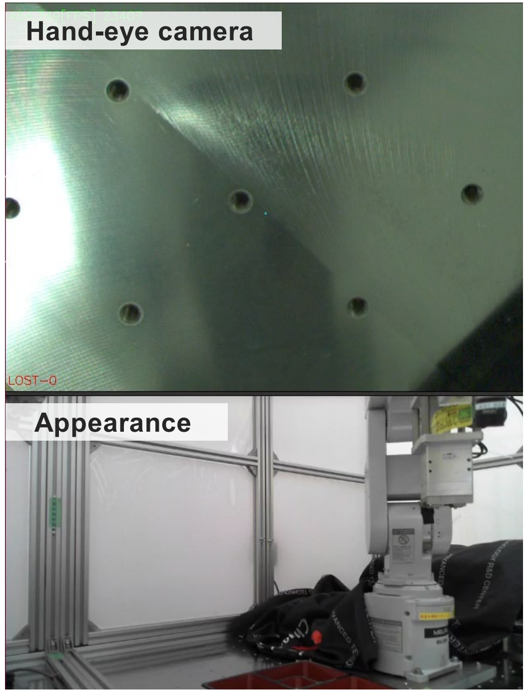
Unnecessary return motion can be suppressed and corrected even for the target position in the middle of the generated trajectory.

Vibration is suppressed by correction considering joint angular velocity and angular acceleration constraints.

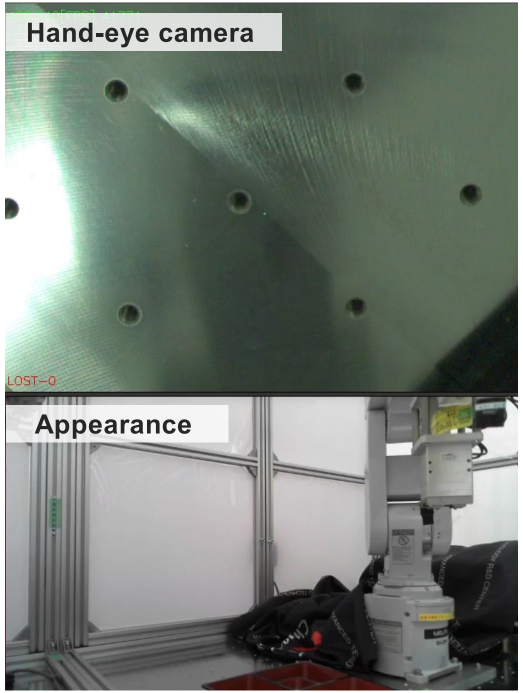
Realize correction with inexpensive 2D camera.
No need to install expensive sensors on existing production equipment.

Diagrams

Conventional method



Development method



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Recognition for Object with Irregular Shapes Using AI

Maisart

Reference Exhibition

Features

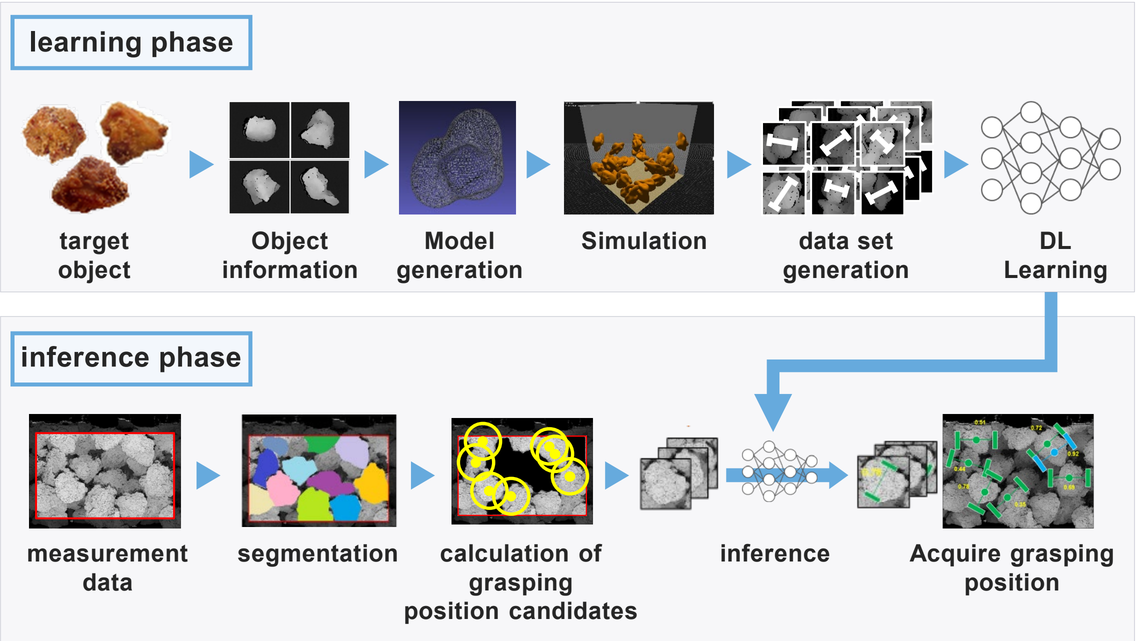
Each object is distinguished by segmentation, and the grasping position is inferred at high speed and with high accuracy by AI.

Acquire the optimum grasping position by AI according to the shape of each object.

Calculate the shape of each object and segmentation based on it.

Image

Process flow (image)



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Recognition for Object with Irregular Shapes Using AI

Maisart

Reference Exhibition

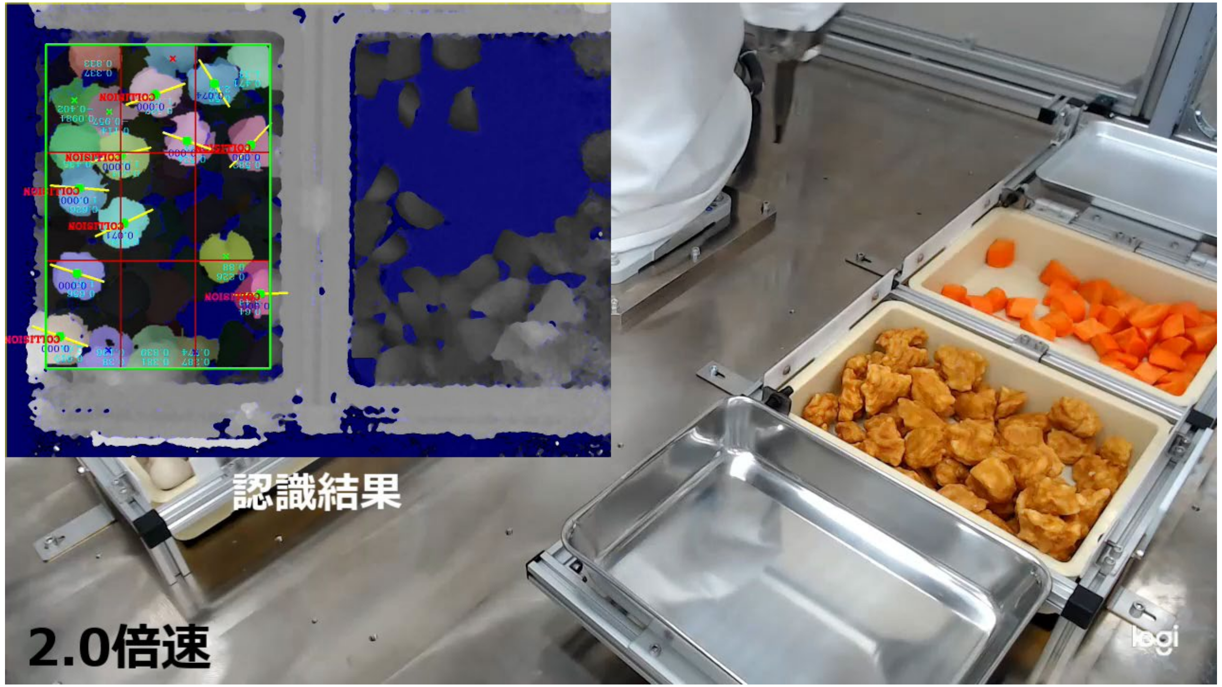
Features

Generate learning data by reproducing irregular position and pose of each object without CAD by simulation.

Obtain the optimum graspping position at high speed with low computational complexity by AI.

No need for a large amount of learning data. Segmentation with only 3D information.
(Learning time is about 10 minutes)

Image



Picking demo example (video)