MITSUBISHI ELECTRIC

Mitsubishi Electric Industrial Robot

CR800 series controller
CR750/CR751 series controller

MELFA-3D Vision 3.0
Instruction Manual

3F-53U-WINM

MELFA

BFP-A3749-D

⚠ Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

⚠ Caution

All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

⚠ Caution

For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

⚠ Warning

Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

⚠ Caution

During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

⚠ Danger

Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

⚠ Caution

Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

⚠ Caution

As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc. Indication of maintenance work in progress

⚠ Caution

Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below. Refer to the actual "Safety Manual" for details.

⚠ Danger — When automatic operation of the robot is performed using multiple control devices (GOT, programmable controller, push-button switch), the interlocking of operation rights of the devices, etc. must be designed by the customer.

⚠ Caution — Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

⚠ Caution — Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

⚠ Caution — Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

⚠ Caution — Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

⚠ Caution — Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

⚠ Caution — Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque.
Exceeding these values could lead to errors or faults.

⚠ Warning — Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

⚠ Warning — Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

⚠ Caution — Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

⚠ Warning — When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.

⚠ Caution — Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

⚠ Caution — After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

⚠ Caution — Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

⚠ Caution — Never carry out modifications based on personal judgments, or use non- designated maintenance parts.
Failure to observe this could lead to faults or failures.

⚠ Warning

When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

⚠ Caution

Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

⚠ Caution

Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

⚠ Danger

Do not connect the Handy GOT when using the GOT direct connection function of this product. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

⚠ Danger

Do not connect the Handy GOT to a programmable controller when using an iQ Platform compatible product with the CR800-R/Q series. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

⚠ Danger

Do not remove the SSCNET III cable while power is supplied to the multiple CPU system or the servo amplifier. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables of the Motion CPU or the servo amplifier. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

⚠ Danger

Do not remove the SSCNET III cable while power is supplied to the controller. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

⚠ Danger

Attach the cap to the SSCNET III connector after disconnecting the SSCNET III cable. If the cap is not attached, dirt or dust may adhere to the connector pins, resulting in deterioration connector properties, and leading to malfunction.

⚠ Caution

Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in errors, such as the emergency stop not being released. In order to prevent errors occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emer- gency stop, and door switch) are working properly after the wiring setup is com- pleted.

⚠ Caution

Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB. When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

⚠ Caution

To maintain the security (confidentiality, integrity, and availability) of the Robot and the system against unauthorized access, DoS*1 attacks, computer viruses, and other cyberattacks from unreliable networks and devices via network, take appropriate measures such as firewalls, virtual private networks (VPNs), and antivirus solutions.
Mitsubishi Electric shall have no responsibility or liability for any problems involving Robot trouble and system trouble by unauthorized access, DoS attacks, computer viruses, and other cyberattacks.
*1 DoS: A denial-of-service (DoS) attack disrupts services by overloading systems or exploiting vulnerabilities, resulting in a denial-ofservice (DoS) state.

⚠ Warning

Do not look directly at light emitted from the projector window of the camera head. Failure to observe this may cause eye impairment. Strict observance is required.

⚠ Caution

The camera head of 3D Vision has a precision structure. Handle with due care and avoid excessive impact.

■ Revision history

Print Date	Instruction Manual No.	Revision Details
2021-1-12	BFP-A3749	・ First print
2023-04-17	BFP- A3749-A	・ Corrected other mistakes and changed some sections.
2023-09-14	BFP- A3749-B	・ Added the CR860 controller. ・ Changed some sections.
2024-03-15	BFP- A3749-C	・ Added support for ENSENSO N36 series cameras. ・ Added a list of savable measurement data. ・ Changed some sections.
2026-01-30	BFP- A3749-D	・ Changed some sections.

■ Introduction

Thank you for considering the use of this option for Mitsubishi Electric industrial robot.
"MELFA-3D Vision" is a compact 3D vision sensor for robots. It employs a camera head capable of acquiring distance information to measure and recognize parts loaded in bulk.
MELFA-3D Vision enables the hand attached to the robot to grip parts loaded in bulk. It is ideal for such tasks as part feeder replacement, and the simplification of positioning units.

When adjusting the model-less recognition of MELFA-3D Vision, the MELFA Smart Plus function extended card automates the adjustment work of the recognition parameter, which requires technical knowledge, using the Mitsubishi Electric AI technology and simulation technology.

Always read over this manual to gain a sufficient understanding of its content before using the “MELFA-3D Vision”.

This instruction manual provides information on the system architecture, product specifications, and usage of "MELFA-3D Vision". For information on basic robot operations, refer to the separate "Instruction Manual/Detailed explanations of functions and operations".

The following are the series described in this instruction manual.

Name	Description
CR800 series	Indicates the CR800 and CR860 controllers.
CR800-Q series	Indicates the CR800-Q and CR860-Q controllers.
CR800-R series	Indicates the CR800-R and CR860-R controllers.

■ Notation used in this manual

⚠ ***Danger***	Incorrect handling may result in imminent danger, leading to death or serious injury.
⚠ ***Warning***	Incorrect handling may lead to death or serious injury.
⚠ ***Caution***	Incorrect handling may result in property damage, or danger leading to impairment of the user.

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<<MEMO>>

1. USING THIS PRODUCT

1.1. Content of This Instruction Manual

In this manual, how to use MELFA-3D Vision is described in the following configuration. For information on robot controller functions and operations, refer to the instruction manual included with the robot controller.

Table 1-1 Instruction manual content

Chapter	Title	Description
1	Using This Product	Describes the construction of this manual.
2	MELFA-3D Vision System Specifications	Describes the MELFA-3D Vision system specifications.
3	Check Before Use	Describes the product configuration and equipment to be prepared by the user. Check whether all the required products have been prepared, and check the versions of the robot controller and RT ToolBox3.
4	Usage	Describes the work required to construct systems using MELFA-3D Vision. Make sure to perform all the steps. Details on each step are provided in Chapters 5 to 10.
5	Installing and Operating the Product	Explains what products must be installed in the system to use MELFA-3D Vision and how to start the application.
6	Device Communication and Connection Settings	Explains how to configure the communication and connection settings of the devices in systems which incorporate MELFA-3D Vision.
7	Calibration	Explains how to find the positional relationship between the robot and camera.
8	Measurement and Recognition Settings	Describes how to configure measurement and recognition settings. Performing measurement and recognition allows you to obtain workpiece position and posture information.
9	Picking	Describes the usage of picking programs based on the workpiece position and posture information obtained in Chapter 8.
10	MELFA-3D Vision Application Exit	Describes how to exit the MELFA-3D Vision application.
11	Maintenance	Describes the procedures of backing up and restoring settings, and uninstalling the software.
12	Robot Program Language Specifications	Describes detailed specifications of MELFA-BASIC language relating to MELFA-3D Vision.
13	Parameter Specifications	Describes detailed specifications for parameters relating to MELFA-3D Vision.
14	Troubleshooting	Describes the details of errors and countermeasures for MELFA-3D Vision.

1.2. Glossary

The following terms are used in this manual.

Table 1-2: Description of terms

Term	Description
Camera head	This term refers to cameras.
Control unit	A unit to receive commands from the robot controller. It sends imaging commands to the camera head, calculates range images, performs recognition from range images, and notifies the robot controller of the recognition results.
USB dongle	A USB device for license authentication. It includes an MELFA-3D Vision 3.0 installer.
Hand eye	A method used to perform measurement and recognition with the camera head attached to the robot hand
Fixed camera	A method used to perform measurement and recognition with the camera head attached on the device frame, etc. The camera head cannot be moved as in the hand eye method.
Workpiece distance	A distance from the camera front end to the workpiece. (Fig. 2-7 Distance to the measurement stand and measurement range)
Calibration	In this instruction manual, calibration means an operation to translate the vision sensor coordinates into robot coordinates (robot calibration).
Job	An executable unit of work such as measurement or recognition executed by the control unit
Measurement	A process to calculate distances within the field of view of the camera using pattern images projected from the projector, and output range images.
Range image	A 2D gray scale image that expresses distance information from the camera head to the workpiece. The closer the camera head, the brighter the image appears.
Recognition	A process to cut out the workpiece from the range image obtained by measurement, and calculate the robot coordinates for the workpiece
Model-less recognition	A recognition method that facilitates the gripping of workpieces by registering the shape of hand claws and suction pads and recognizing gaps into which claws can be inserted and pad suction locations. No need to register workpiece shapes. Depending on the circumstances, a 2D vision sensor may be required.
Segment	Refers to a small area of any size in the captured image, it is one of the processing units in the image processing. It is divided into segments subjected to various processes to the captured image or the distance image.
Model matching recognition	A recognition method that facilitates the gripping of workpieces by registering workpiece shapes in 3D-CAD models and recognizing workpieces that match the 3D-CAD models
Workspace	A space to temporarily retain the captured images and range images obtained during measurement and the recognition results and recognized images obtained during recognition.
MELFA Smart Plus card pack MELFA Smart Plus card Note 1	A function extended card for the CR800 robot controller. The MELFA Smart Plus card pack can use all of the MELFA Smart Plus functions. The MELFA Smart Plus card can use one of the MELFA Smart Plus functions. In MELFA-3D Vision, MELFA-3D Vision extended functions such as the automatic adjustment of the recognition settings can be used. For details, refer to "MELFA Smart Plus User's Manual".

Note 1: When the robot controller software version is Ver.E4 or later, extended MELFA-3D Vision functions are available without the MELFA Smart Plus card or the card pack.

2. MELFA-3D VISION SYSTEM SPECIFICATIONS

2.1. What is MELFA-3D Vision?

MELFA-3D Vision is software that connects a compact 3D vision sensor for robots to measure and recognize parts. It employs a camera head capable of acquiring distance information to measure and recognize parts loaded in bulk.

Using MELFA-3D Vision and a compatible camera head enables the hand attached to the robot to grasp parts loaded in bulk. It is ideal for such tasks as part feeder replacement, and the simplification of positioning units.

■ Main features

(1) The camera head is available for both hand eyes and fixed cameras.
(2) High-speed, high-accuracy measurement
(3) Various workpieces loaded in bulk can be taken out simply by registering the hand tip shape.
(Model-less recognition)
(4) Gripping of bulk-loaded workpieces is possible in consideration of their posture by registering the workpiece shape. (Model matching recognition)
(5) Sensor settings and operation checks can be easily performed using a computer.
No need to keep connection with the computer during operation.

2.1.1. Recognition method

■ Model-less recognition

A recognition method that facilitates grasping of workpieces by registering the shapes of hand tabs and suction pads and searching for gaps into which tabs can be inserted and pad suction locations. Therefore, registering the workpiece shape is not required. Enter the hand tab and suction pad shapes. Registering the workpiece model is not required regardless of the workpiece type.

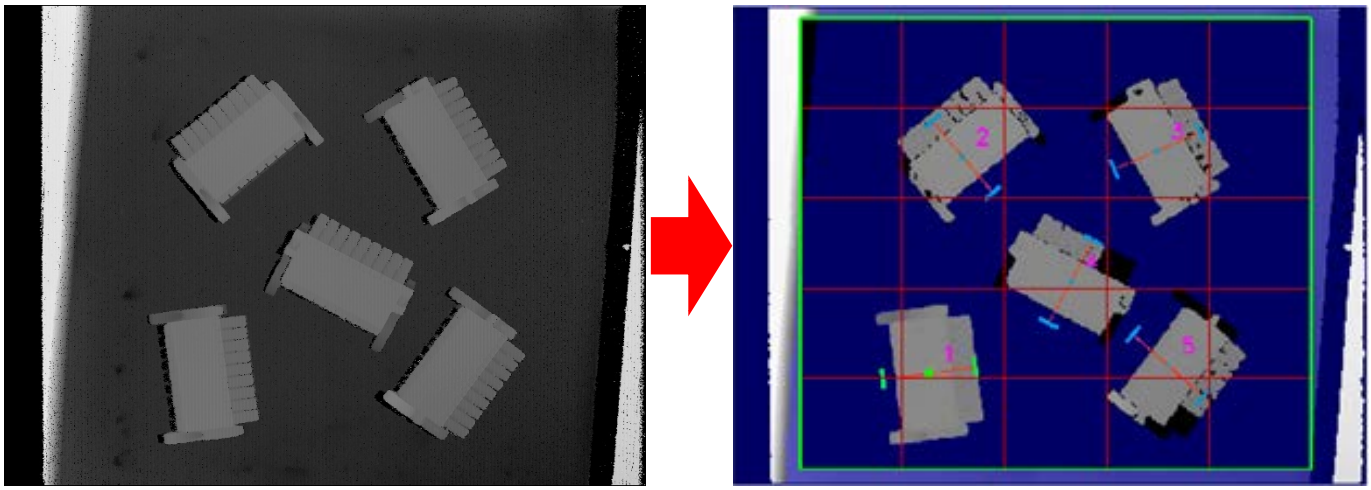


Fig. 2-1 Model-less recognition

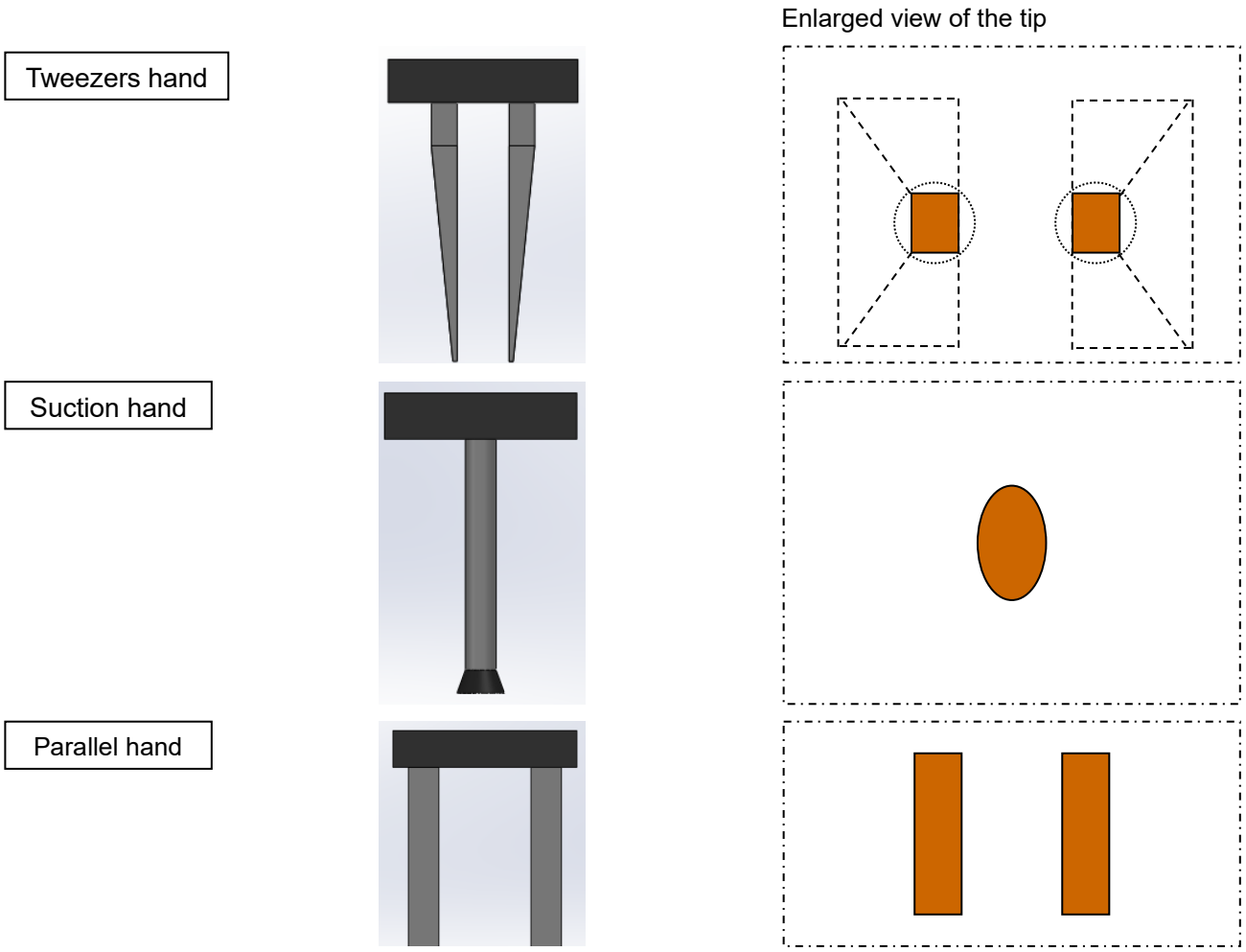


Fig. 2-2 Model-less recognition: Hand setting example

■ Model matching recognition

A recognition method that facilitates the gripping of workpieces by registering workpiece shapes in 3D-CAD models and searching for workpieces that match the 3D-CAD models. Therefore, the gripping location and posture of the workpieces can be identified.

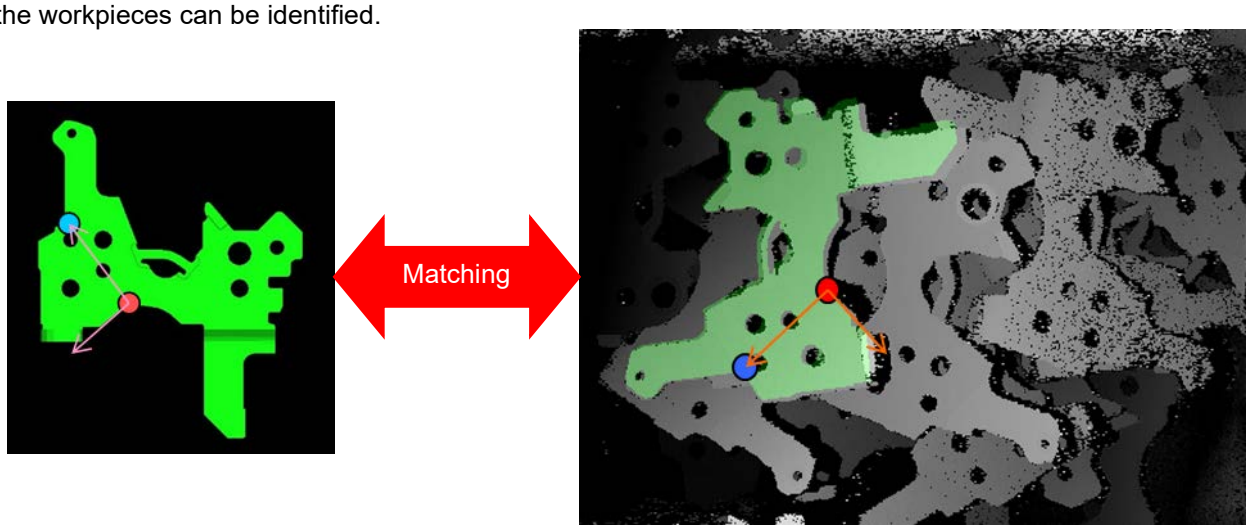


Fig. 2-3 Model matching recognition

2.1.2. Extended function

2.1.2.1. Recognition parameter automatic adjustment AI

For adjustment during model-less recognition of MELFA-3D Vision, extended MELFA-3D Vision functions are used to automate expert-level adjustment of recognition parameters through proprietary AI and simulation technologies.

The AI automatically adjusts the appropriate parameters in the virtual space. The parameters can be adjusted only with the 3D-CAD data Note 1 without preparing the actual device.

Note 1: The supported data format is the STL format, OBJ format, and PLY format. However, data that includes color information is not supported.

Recognition parameter automatic adjustment AI is available for the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR.

It is not available for the ENSENSO N36 series or MELFA ASSISTA series.

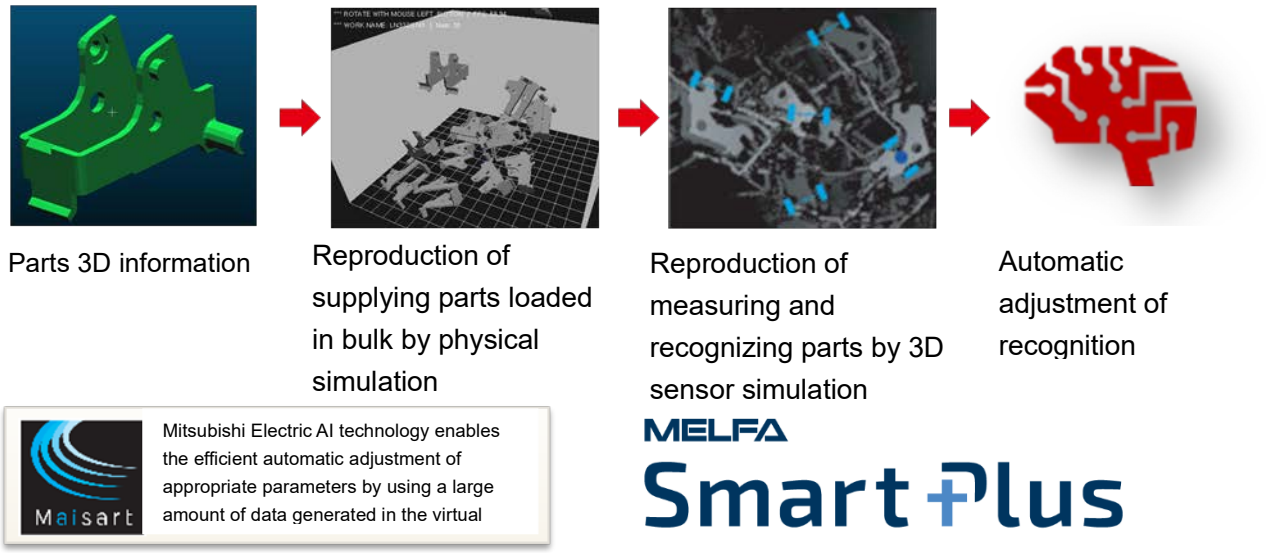


Fig. 2-4 Recognition parameter automatic adjustment AI

2.2. System Configuration Example

2.2.1. F series (CR750/751 controllers supported)

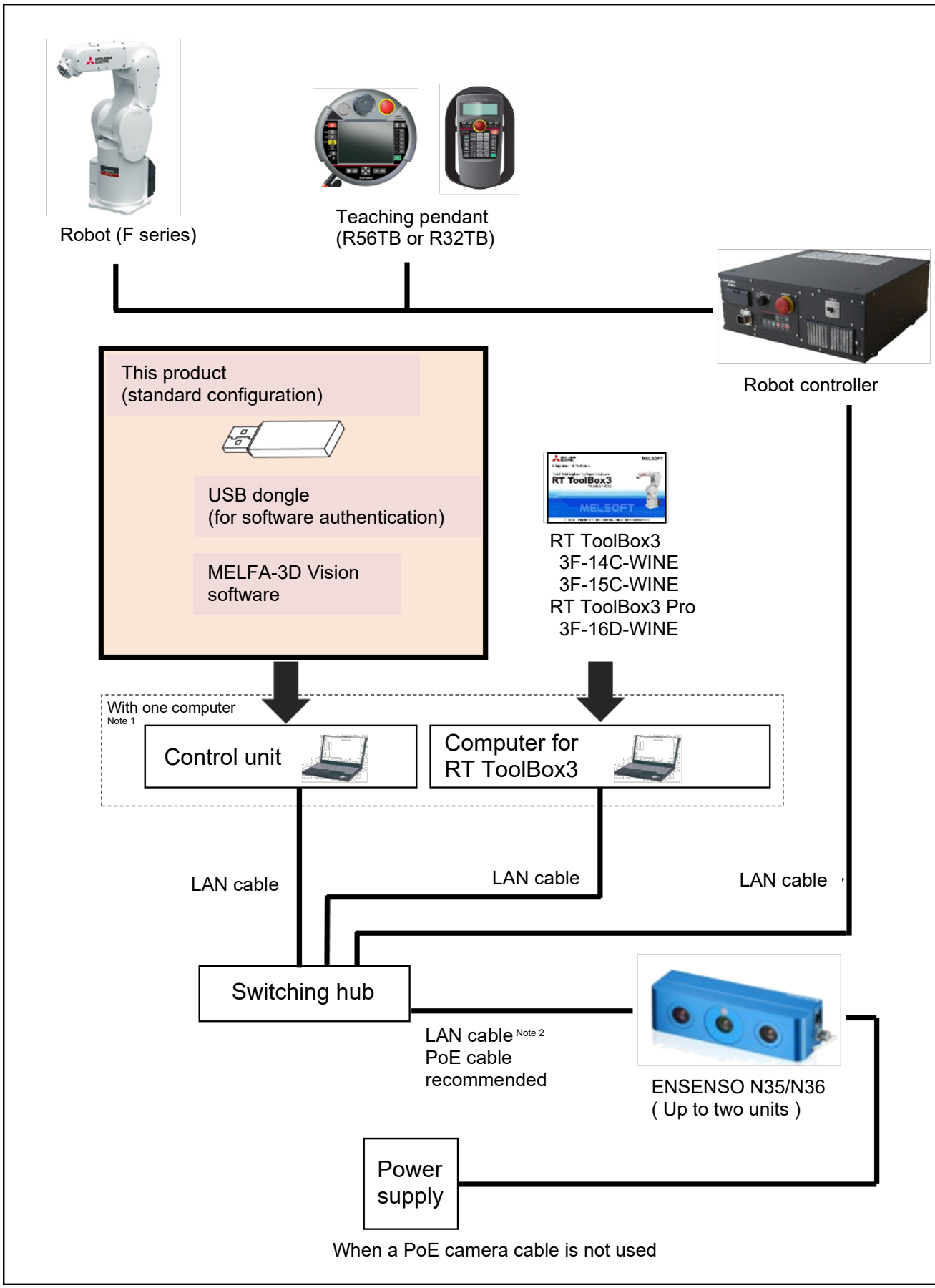


Fig. 2-5 MELFA-3D Vision system configuration drawing (F series)

Note 1: The control unit and RT ToolBox3 can be operated with one computer.

Note 2: Use a PoE LAN cable. If a PoE LAN cable is not used, a power cable is required for the camera. When using the camera with a hand eye, use a cable that withstands bending.
For use in IP65 or IP67 environments, use a cable that meets IP65 or IP67 requirements.
MELFA-3D Vision-compatible PoE LAN cable: ENSENSO AD00268 ("Table 3-2: List of items prepared by customer" for further details)

2.2.2. FR series (CR800 series controller supported)

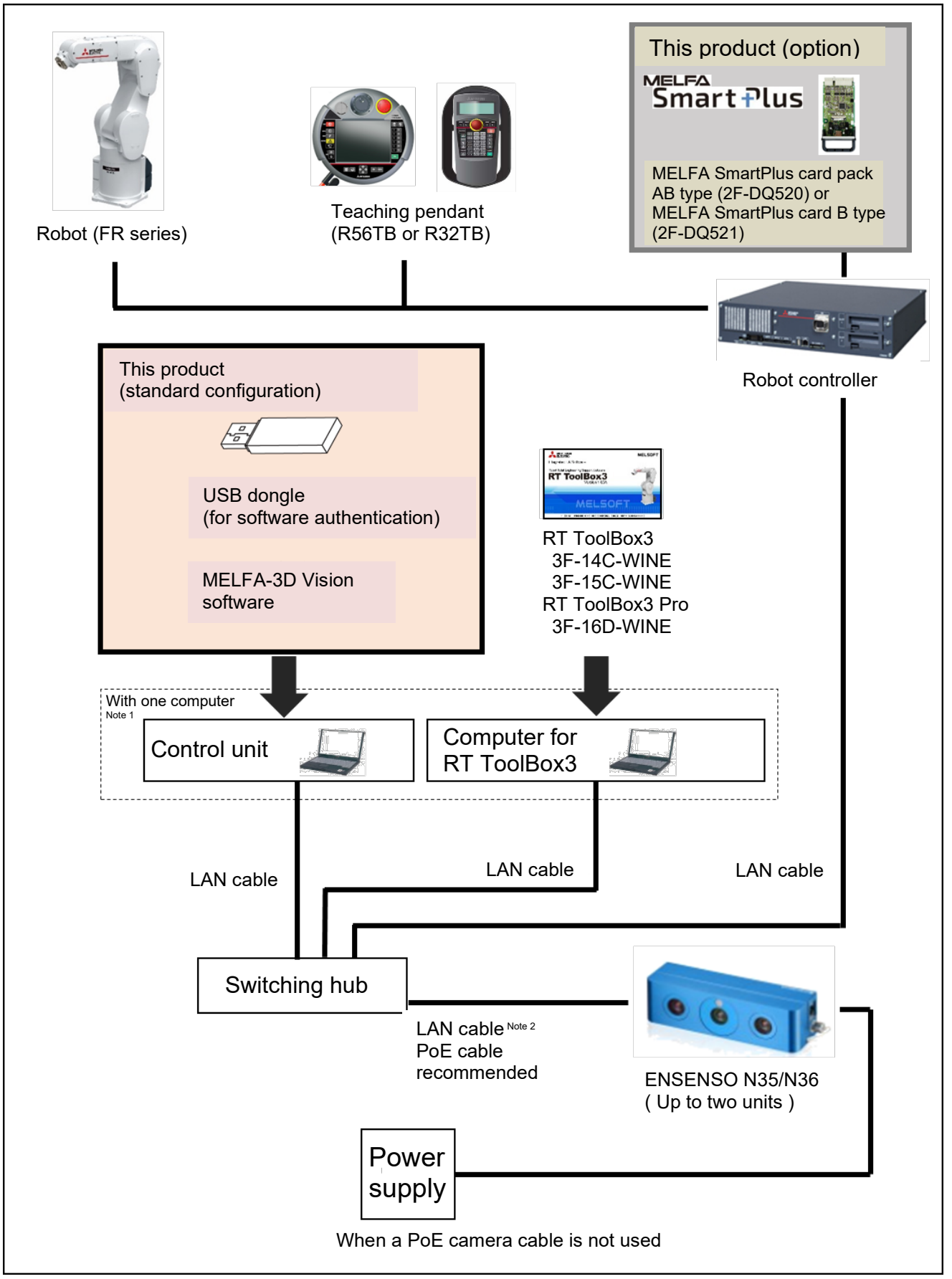


Fig. 2-6 MELFA-3D Vision system configuration drawing (FR series)

Note 1: The control unit and RT ToolBox3 can be operated with one computer.

Note 2: Use a PoE LAN cable. If a PoE LAN cable is not used, a power cable is required for the camera. When using the camera with a hand eye, use a cable that withstands bending.
For use in IP65 or IP67 environments, use a cable that meets IP65 or IP67 requirements.
MELFA-3D Vision-compatible PoE LAN cable: ENSENSO AD00268 ("Table 3-2: List of items prepared by customer" for further details)

2.3. MELFA-3D Vision 3.0 Specifications

Table 2-1: MELFA-3D Vision 3.0 specifications

Item			Function details
Applicable robot Note 1			RV-F, RH-FH series RV-FR, RH-FRH series RV-CR, RH-CRH series MELFA ASSISTA series
Robot programming language			MELFA-BASIC VI or MELFA-BASIC V
Robot controller	MELFA-3D Vision dedicated commands		Dedicated commands used to notify the control unit of calibration and job execution commands, and to acquire recognition results.
Connection settings	Number of set camera heads		Max. 2
	Number of set robots		Max. 4
Calibration	Number of calibration data		Max. 15
	Non-contact type calibration		Available for fixed cameras and hand eyes Auto calibration possible (partial teaching is required for robots other than vertical 6-axis robots)
	Contact type calibration		Available for fixed cameras Manual calibration by teaching 5 points
Measurement Note 2			Send imaging commands to the camera head and calculate range images from captured pattern images.
	Measurement time		N35 series: approx. 0.8 seconds; N36 series: approx. 0.8 seconds Note 3
	Number of measurement points		N35 series: 1.3 million; N36 series: 1.95 million
	Measurement sensitivity		"HDR measurement" selectable Pseudo dynamic range extension with two-time measurements (low exposure and high exposure)
	Function to improve measurement accuracy		ENSENSO's accuracy improvement technology "FLEXVIEW" selectable
Job	Number of registered job		Max. 250
	Model-less recognition		A recognition method that facilitates the gripping of workpieces by registering the shape of hand claws and suction pads and recognizing gaps into which claws can be inserted and pad suction locations.
		Recognition result output information	Posture output "0": Workpiece position in camera coordinates (XYZC) Note 4 Posture output "1 to 6": Workpiece position in robot coordinates (XYZABC) Note 4
		Recognition time	N35 series: approx. 0.5 seconds; N36 series: approx. 0.7 seconds Note 3
	Model matching recognition Note 5		A recognition method that facilitates the gripping of workpieces by registering workpiece shapes in 3D-CAD models and recognizing workpieces that match the 3D-CAD models
		Workpiece registration size/piece	Max. 8,500,000 bytes (8.1 MB)
		Workpiece 3D-CAD data format	STL format, OBJ format, and PLY format
		Number of registered workpieces	Max. 250
		Number of registered workpiece parameters per workpiece	Max. 10
		Number of workpiece lists	Max. 250
		Number of recognition targets per workpiece list	Max. 100

		Recognition result output information	Workpiece position in robot coordinates (XYZABC)
		Recognition time	Approx. 1.0 s Note 3
	Recognition parameter automatic adjustment AI Note 7		When adjusting the model-less recognition, the adjustment work in Recognition parameters, which requires technical knowledge, is automated using the Mitsubishi Electric AI technology and simulation technology. Note 6
		Workpiece registration size/piece	Max. 8,500,000 bytes (8.1 MB)
		Workpiece 3D-CAD data format	STL format, OBJ format, and PLY format Note 8
		Adjustment time	Approx. 10 to 60 min Note 9
RT ToolBox3	Connection settings		The function used to specify camera and robot communication settings
	Calibration		The function used to create and edit calibration data
	Measurement/recognition		The function used to create and edit jobs for measurement and recognition
	Monitoring		The function used to monitor measurement and recognition results
	Maintenance		The function used to back up and restore data inside the control unit

Note 1: The RV-F series or the RV-FR series is not compatible with internal wiring specifications.

Note 2: Shielding may be required against the influence of ambient environmental light.
Projector light weakens as the working distance increases, enhancing the influence of ambient environmental light.
Measurement is not possible for workpieces with the following characteristics.
・ Transparent objects, specular objects
Measurement and recognition of workpieces with the following characteristics may be difficult.
・ High-gloss objects, black-colored objects, dark-colored objects, objects with complex surface shape
Request sample testing if it is difficult to judge whether measurement is possible or not.

Note 3: This indicates the standard time under the best conditions. The standard time may be exceeded depending on the conditions such as the control unit performance, ambient environment, workpiece, processing parameters, and the number of registered jobs.

Note 4: For posture output, refer to "Posture output" in "Table 8-11: Recognition parameters".
For a picking operation of the model-less recognition, a 2D vision sensor may be required.

Note 5: The RH-FH series and the RH-FRH series are not compatible with the model matching recognition.
ENSENSO N36 series cameras are not supported.

Note 6: For the parameters that can be adjusted by the recognition parameter automatic adjustment AI ("2.1.2 Extended function"), refer to "Table 8-11: Recognition parameters".

Note 7: Recognition parameter automatic adjustment AI is available for the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR.
The MELFA-3D Vision extended function is not available for the MELFA ASSISTA series.

Note 8: Data that includes color information is not supported.

Note 9: Time varies depending on conditions such as control unit capability, workpiece 3D CAD data, and learning environment settings.

⚠ Caution

Cannot be used with any safety function.
Safety functions cannot be implemented only with MELFA-3D Vision. Take appropriate preventative safety measures as required.

Table 2-2: USB dongle specifications

Item	Specifications
External dimensions mm x mm x mm	62.1 x 17.0 x 10.0
Weight	9.0g
License authentication function	Software license authentication Note 1
Dustproof and drip-proof	Not equipped Note 2
Operating temperature/humidity	0°C to +50 °C/0 to 85% RH Note 3
Storage temperature/humidity	-20°C to +85 °C/0 to 85% RH Note 3

Note 1: This product uses an application to periodically read the serial number of the USB dongle and perform license authentication. When using MELFA-3D Vision 3.0, leave the USB dongle plugged into the control unit at all times.

Note 2: Additionally, this product cannot be used in oil mist environments.

Note 3: Avoid external factors such as condensation and static electricity.

⚠ Caution

Use this product in environments where the risk of a fire or overheating due to gas, liquid, dust, steam, or components of such substances can be avoided.

2.3.1. Compatibility with former product

MELFA-3D Vision 3.0 (3F-53U-WINM) is not compatible with MELFA-3D Vision (4F-3DVS2-PKG1 / 4F-3DVS2-PKG2) or MELFA-3D Vision 2.0 (4F-3DVS2-PKG3). MELFA-3D Vision 2.0 and MELFA-3D Vision 3.0 cannot be installed on the same control unit. If MELFA-3D Vision 2.0 has already been installed on the control unit, installing 3.0 will upgrade the version to 3.0. MELFA-3D Vision 2.0 and MELFA-3D Vision 3.0 cannot be installed on older MELFA-3D Vision control units.

2.4. Camera Head Specifications

MELFA-3D Vision 3.0 is compatible with the camera models shown below. (Refer to "Table 3-2: List of items prepared by customer".).

・ENSENSO N35 series (infrared type) N35-***-**- IR

・ENSENSO N36 series (infrared type) N36-***-**- IR

* The specifications of each ENSENSO N35 / N36 model are uniquely defined. Select and use an appropriate model according to the field of view size and working distance.

The following shows the specifications of the ENSENSO N35 / N36 camera head.

* Recognition parameter automatic adjustment AI is available for the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR. For details, refer to "5.2 When Using the MELFA-3D Vision Extended Function".

Table 2-3: ENSENSO N35 camera head specifications

Item		Function details
Weight		0.65kg
Resolution		1280 x 1024 (1280 x 960 Note 1)
Frames per second		10 (1.3 MP)
Interface		Gigabit Ethernet
Input		1 x Trigger
Output		1 x Flash / GPIO
Power supply		12 V – 24 V DC / PoE class3 device (6.49 to 12.95W)
Projector		Projection light: Infrared (850 nm)
Temperature		(During operation) 0 to 40 °C (During storage) 0 to 50 °C
Humidity		100% RH (Non-condensing)
Vibration resistance		30 to 500 Hz 10 G (sinusoidal wave)
Shock resistance		80 G, 1.9 ms/25 G, 6 ms (half-sinusoidal wave)
IP rating		IP65 / IP67
Optical characteristics Note 2	Focal length and convergence angle	The following website allows you to check the specifications by selecting the N35 series camera best suitable for the working distance and field of view being used. https://en.ids-imaging.com/ensenso-selector.html
	F value	
	Operating distance mm (Working distance)	
	Field of view size (Measurement range) (reference value) mm x mm	
	Z measurement accuracy (reference value) mm Note 3	
External dimensions Note 4 mm x mm x mm		175 x 52 x 50
Calibration plate/pattern	Size mm x mm	The following website allows you to check the specifications by selecting the N35 series camera being used. https://en.ids-imaging.com/ensenso-selector.html
Cable (PoE) Note 5 (MELFA-3D Vision-compatible)	Model	AD00268
	Interface	Gigabit Ethernet
	Cable length	10 m (bending type)
	IP rating	IP65 / IP67

Table 2-4: ENSENSO N36 camera head specifications

Item		Function details
Weight		0.65kg
Resolution		1936 x 1216 (1616 x 1212 Note 1)
Frames per second		8 (2.3 MP)
Interface		Gigabit Ethernet
Input		1 x Trigger
Output		1 x Flash / GPIO
Power supply		24 V DC / PoE class3 device (6.49 to 12.95W)
Projector		Projection light: Infrared (850 nm)
Temperature		(During operation) 0 to 40 °C (During storage) 0 to 50 °C
Humidity		100% RH (Non-condensing)
Vibration resistance		30 to 500 Hz 10 G (sinusoidal wave)
Shock resistance		80 G, 1.9 ms/25 G, 6 ms (half-sinusoidal wave)
IP rating		IP65 / IP67
Optical characteristics Note 2	Focal length and convergence angle	The following website allows you to check the specifications by selecting the N36 series camera best suitable for the working distance and field of view being used. https://en.ids-imaging.com/ensenso-selector.html
	F value	
	Operating distance mm (Working distance)	
	Field of view size (Measurement range) (reference value) mm x mm	
	Z measurement accuracy (reference value) mm Note 3	
External dimensions Note 4 mm x mm x mm		175 x 52 x 50
Calibration plate/pattern	Size mm x mm	The following website allows you to check the specifications by selecting the N36 series camera being used. https://en.ids-imaging.com/ensenso-selector.html
Cable (PoE) Note 5 (MELFA-3D Vision-compatible)	Model	AD00268
	Interface	Gigabit Ethernet
	Cable length	10 m (bending type)
	IP rating	IP65 / IP67

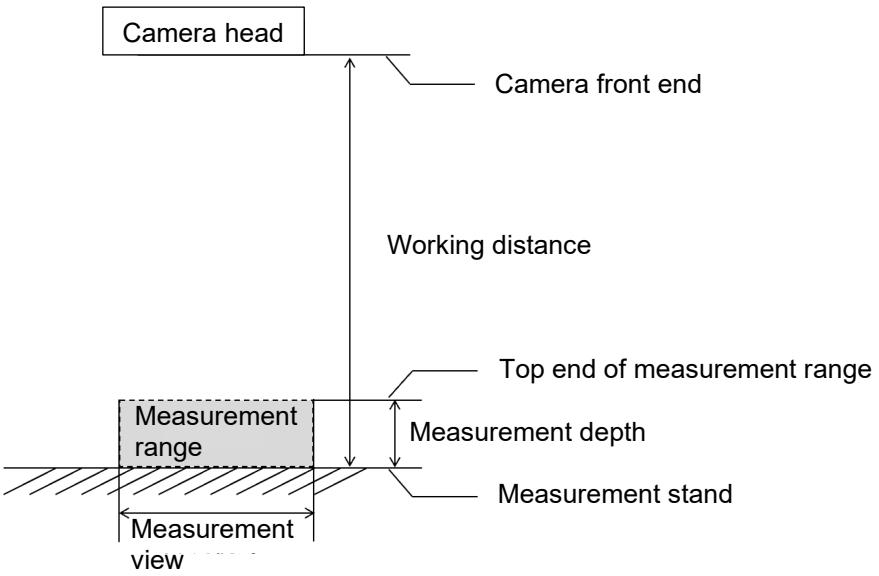


Fig. 2-7 Distance to the measurement stand and measurement range

Note 1: When MELFA-3D Vision is used, the resolution is 1280 × 960 (N35) and 1616 × 1212 (N36).

Note 2: The measurement range (between top end of the measurement range and measurement stand) must be within the range defined in the working distance specification of the camera. For MELFA-3D Vision, the depth of the measurement range is 6% less than that of the camera head's measurement range. (Refer to the following table.)

Model	N35-804-16-IR	N35-806-16-IR	N35-808-16-IR	N35-1204-16-IR	N35-1604-20-IR
Measurement range	388×291 to 860×645	287×215 to 435×326	231×173 to 290×217	315×236 to 431×323	248×186 to 268×201

Model	N36-802-16-IR	N36-804-16-IR	N36-806-16-IR
Measurement range	522x411 to 1559x1233	334x257 to 601x463	249x190 to 315x252

Note 3: This is the measurement value variation range, and differs from the absolute measurement accuracy. Furthermore, this is a reference value. This value changes depending on the working distance, sensor parameters, and the workpiece shape and surface condition.

Note 4: Protrusions are not included.

Note 5: It is recommended to use a PoE LAN cable. If a PoE LAN cable is not used, a power cable is required for the camera. When using the camera with a hand eye, use a cable that withstands bending. For use in IP65 or IP67 environments, use a cable that meets IP65 or IP67 requirements. For MELFA-3D Vision, it is recommended to use the following PoE LAN cable. PoE LAN cable: AD00268 ("Table 3-2: List of items prepared by customer" for further details)

2.4.1. Protection specifications and working environment

The camera head complies with IEC standards IP65 / IP67 (dustproof and drip-proof).
Please note that the IP performance of IEC standard specifies the protection level against solid bodies and water, not against oil. Take care not to directly expose the camera head to oil and so on.

2.4.2. Name of each part

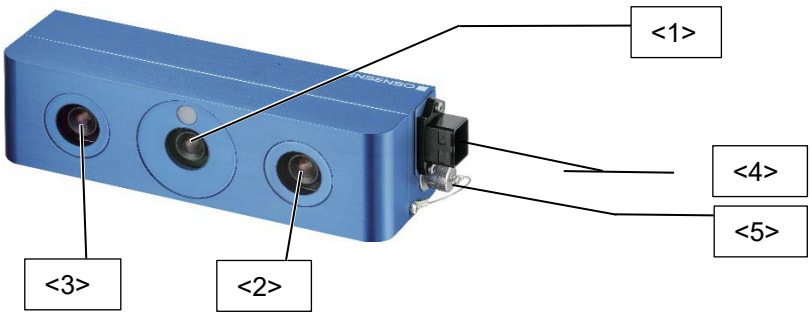


Fig. 2-8 Names of camera head parts

<1> Projector……..……Light is projected from here.
<2> Camera lens (left side) ……..……..….A lens is attached.
<3> Camera lens (right side) ……..……A lens is attached.
<4> PoE port……Used to connect a PoE switching hub for communication and power supply. If a dedicated communication cable is used, a power cable is required for the camera.
(Refer to "Table 2-3: ENSENSO N35 camera head specifications".)
(Refer to "Table 2-3: ENSENSO N35 camera head specifications".)
<5> Power/external trigger signal connector…….Connect a dedicated cable when using a power cable or external trigger signals.
(Refer to "Table 2-3: ENSENSO N35 camera head specifications".)
(Refer to "Table 2-3: ENSENSO N35 camera head specifications".)

2.4.3. External dimensions

The external dimensions are shown below.

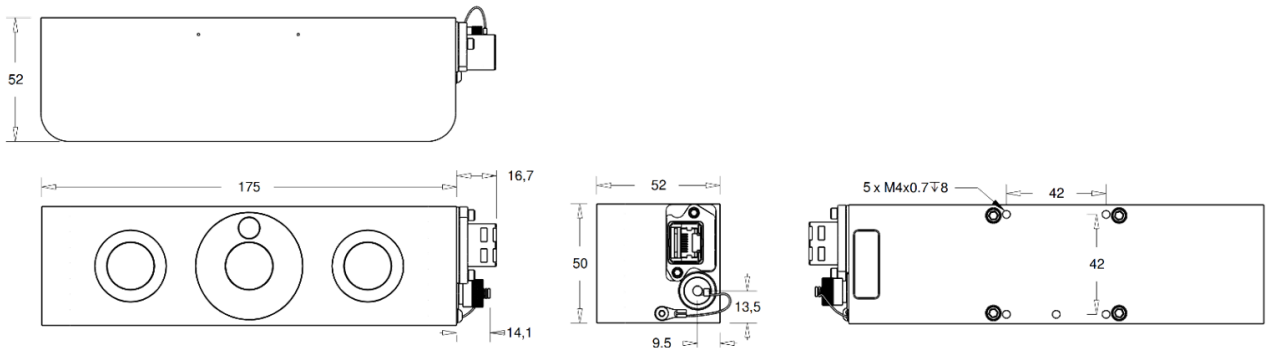
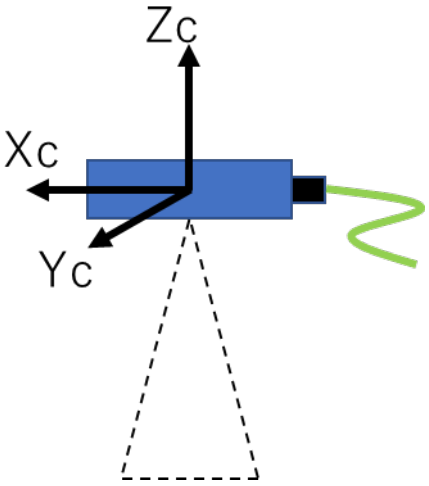


Fig. 2-9 External dimensions of the camera head (ENSENSO N35/N36)

2.4.4. Camera coordinate system

The coordinate systems of the ENSENSO N35/N36 camera and measured images are defined as shown below. For information on the origin in the camera coordinate system, refer to "8.2 Measurement settings".

Camera coordinate system



2.5. Restrictions

2.5.1. Restrictions applicable to measurement and recognition

(1) Measurement is not possible for workpieces with the following characteristics.
- Transparent objects
- Specular objects

(2) Measurement and recognition of workpieces with the following characteristics may be difficult. Furthermore, the greater the workpiece distance, more restrictions are placed on the conditions allowing measurement.
- High-gloss objects
- Black-colored objects
- Dark-colored objects
- Objects with complex surface shape

(3) Workpiece size (reference values)
The workpiece size must meet the following conditions.
For model-less, the shorter side is about 1/25 or more of the measurable range, and the longer side is about 1/3 or more of the measurable range.
For model-matching, the shorter side is about 1/10 or more of the measurable range, and the longer side is about 1/3 or more of the measurable range.
* The values change depending on conditions such as the working distance, sensor parameters, workpiece shape and surface condition. Therefore, the values are reference values based on our test conditions.
If it is difficult to determine whether measurement is possible, contact us for sample tests.

For information on the measurable range of each model, refer to the following website:
https://en.ids-imaging.com/ensenso-n35.html

2.5.2. Picking with model-less recognition

Model-less recognition (refer to "2.1.1 Recognition method") cannot be used to pick up workpieces considering their posture. Consequently, a 2D vision sensor may be required for re-gripping of workpieces after they are taken out.
Furthermore, there may also be times when the hand claw interferes with the wall of the parts supply box for workpieces located in the corner of the box, preventing those workpieces from being taken out.

3. CHECK BEFORE USE

3.1. Product Check

This product includes the following items. Ensure that package contains the following items. If any item is missing, please contact the branch office or distributor from which you purchased the product.

Table 3-1: MELFA-3D Vision product configuration list

No.	Parts name	Model name	Qty	Appearance	Remarks
(1)	MELFA-3D Vision 3.0 • MELFA-3D Vision software • Instruction manual • Sample program • END-USER SOFTWARE LICENSE AGREEMENT	3F-53U-WINM	1		-
(2)	QUICK START GUIDE		1		-
(3) Note 1 Note 3	MELFA Smart Plus card pack/ MELFA Smart Plus card[*1]	2F-DQ520 / 2F-DQ521	1 Note 2		MELFA Smart Plus Required when using the MELFA-3D Vision extended function

Note 1: MELFA Smart Plus card pack and MELFA Smart Plus card are options (sold separately).

Note 2: Use either the MELFA Smart Plus card pack or the MELFA Smart Plus card.

Note 3: When the robot controller software version is Ver.E4 or later, extended MELFA-3D Vision functions are available without the MELFA Smart Plus card or the card pack.

3.2. Items to be Prepared by Customer

To configure the system, prepare necessary equipment in addition to this product. The minimum requirements are shown in Table 3-2: List of items prepared by customer

Table 3-2: List of items prepared by customer

No.	Parts name	Specification	Qty	Remarks
(1)	Control unit	OS: Windows 10 Professional/Enterprise (64bit) CPU: Intel Core i7 (ninth generation) RAM: 8 [GB] or more HDD: 100 [GB] or more Gigabit Ethernet port × 1	1	For MELFA-3D Vision software
(2)	Computer to operate RT ToolBox3	Computer with RT ToolBox3 installed * Operating condition of RT ToolBox3	1	For settings (Also available for item (1))
(3)	Switching hub Note 1	1000BASE-T or higher PoE supported	1	Devices whose operation has been confirmed ・GS308P (NETGEAR) ・BS-GS2024P (Buffalo)
(4)	LAN cable	Category 5e or higher	3	・Between (1) and (3) ・Between (2) and (3) ・Between the robot controller and (3) * Use 2 cables when using (1) and (2).
(5)	Camera head installation jig	—	1	A jig to fix the camera head (item (6)) (Refer to "3.4 Camera Head Attachment Type".)
Required items distributed by IDS Imaging Development Systems GmbH				
(6)	Camera head • ENSENSO N35 / N36 series (infrared type) N35-***-**-IR N36-***-**-IR	Refer to "2.4 Camera Head Specifications". Manufacturer: ENSENSO GmbH (Distributor: IDS Imaging Development Systems GmbH)	1	For more information, go to the following website: https://en.ids-imaging.com/ensenso-selector.html
(7)	LAN cable Note 2 • AD00268	Category 5e or higher PoE supported Cable length: 10 m (Distributor: IDS Imaging Development Systems GmbH)	1	• Connection between items (3) and (6) Recommended for MELFA-3D Vision
(8)	Calibration plate/pattern Note 3	A calibration plate compatible with the camera head (item (6)) (Distributor: IDS Imaging Development Systems GmbH)	1	For more information, go to the following website: https://en.ids-imaging.com/ensenso-selector.html

For further information on items (6) through (8), contact the following company:
IDS Imaging Development Systems GmbH
https://en.ids-imaging.com/global-presence.html

Note 1: Use a switching hub that supports Gigabit Ethernet and PoE. If a PoE cable is not used, a power cable is required for the camera.
(For details, refer to "Table 14-4: MELFA-3D Vision 3.0-compatible camera models and recommended accessories".)

Note 2: It is recommended to use a PoE LAN cable. If a PoE LAN cable is not used, a power cable is required for the camera. When using the camera with a hand eye, use a cable that withstands bending. For use in IP65 or IP67 environments, use a cable that meets IP65 or IP67 requirements.
Recommended PoE LAN cable: AD00268
(For details, refer to "Table 14-4: MELFA-3D Vision 3.0-compatible camera models and recommended accessories".)

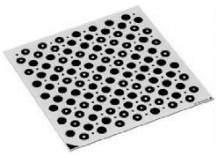
Note 3: Use a calibration plate or pattern compatible with the models shown below.
Select the camera being used on the following website to find an appropriate calibration plate/pattern.
https://en.ids-imaging.com/ensenso-selector.html

■ Products distributed by IDS Imaging Development Systems GmbH

(6) ENSENSO N35 / N36 (infrared type)
N35-***-**-IR
N36-***-**-IR

(7) PoE cable AD00268 (recommended for MELFA-3D Vision)

(8) Calibration plate/pattern



3.3. Software Version

In order to use MELFA-3D Vision, it is necessary that all software support MELFA-3D Vision. Check all versions prior to use.

3.3.1. Function comparison between MELFA-3D Vision 3.0 software versions

The table below shows the difference in functions supported by MELFA-3D Vision versions 3.0 and 3.1.

MELFA-3D Vision 3.0 software version / Item	Ver.3.0 Note1	Ver.3.1	
Compatible cameras	ENSENSO N35 series	ENSENSO N35 series	ENSENSO N36 series Note2
Model-less recognition	○	○	○
Model matching recognition	○	○	×
Recognition parameter automatic adjustment AI	Supported models only Note3	Supported models only Note3	×

Note 1: Includes Ver. 3.0.1 and Ver. 3.0.2.
Note 2: N35 and N36 cameras can be connected at the same time.
Note 3: Only the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR are supported.

■ How to check the software version of MELFA-3D Vision 3.0
Access the MELFA-3D Vision 3.0 installation folder (C:\Program Files\MITSUBISHI ELECTRIC\MELFA-3D Vision). Right-click MELFA_EYE.exe, then go to [Properties] → [Details] → [File version].

3.3.2. Robot controller

Parts name	Model name	Compatible version
Controller Note3	CR750-Q/CR751-Q Note2	Ver.R6e or later Note1
	CR750-D/CR751-D Note2	Ver.S6e or later Note1
	CR800-D/CR800-R/CR800-Q	Ver.A1 or later Note4
	CR860-D/CR860-R/CR860-Q	Ver.D1 or later

Note 1: For CR750/CR751 series controllers, the upper limit of the recognized number of pieces for model-less recognition changes depending on the software version.
- Ver.R6e/S6e or later: Up to 50
- Ver.R6e/S6e or earlier: Up to 10

Note 2: The MELFA-3D Vision extended functions cannot be used in the CR750/CR751/CR860 series controllers.
Note 3: The system status variable M_V3Rmn1/M_V3Rmn2 cannot be used for MELFA-BASIC V.
Note 4: For Ver. A3 or earlier, the MELFA-3D Vision extended function or system status variable M_V3Rmn1/M_V3Rmn2 cannot be used.

3.3.3. Supported software

Parts name	Model name
MELSOFT RT ToolBox3	3F-14C-WINJ 3F-14C-WINE
MELSOFT RT ToolBox3 mini	3F-15C-WINJ 3F-15C-WINE
MELSOFT RT ToolBox3 Pro	3F-16D-WINJ 3F-16D-WINE

Versions of RT ToolBox 3 that are compatible with MELFA-3D Vision differ depending on the version of MELFA-3D Vision you are using. Refer to the table below to check that you are using software versions that are compatible with each other.

Version compatible with RT ToolBox3
Ver. 1.82L or later (Ver. 2.30G or later for the ENSENSO N36.)

3.3.4. Supported SDK and driver versions

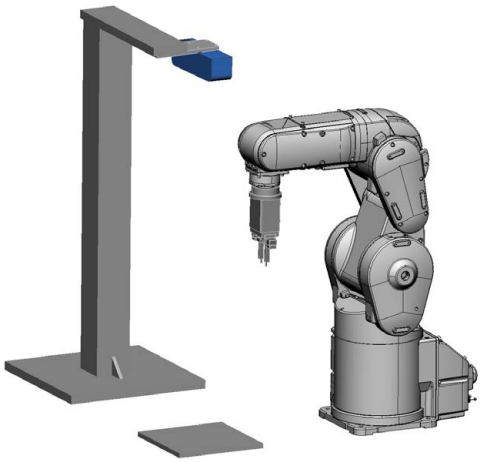
MELFA-3D Vision 3.0 supports the following SDK and driver versions.
The following components are installed at the time of MELFA-3D Vision installation. Check the versions to be installed. If the following components have already been installed on the computer, attempting to install MELFA-3D Vision will display a message requesting the uninstallation as shown in "5.3 MELFA-3D Vision software installation procedure".

Component	Supported version
ENSENSO SDK	Ver. 2.3 (Ver. 3.5 for the ENSENSO N36.)
uEye camera driver	Ver.4.90

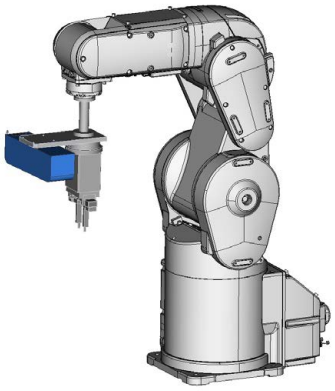
3.4. Camera Head Attachment Type

There are two types of methods to attach the camera head as follows. The advantages and disadvantages of these types are stated below. Select the attachment type suitable to your usage.
Both types require an installation jig (supplied by customer).

■Fixed cameras
< Advantages>
(1) Cycle time can be reduced because measurement is possible during robot operation.
(2) There are a few restrictions on the payload because the camera is not attached to the robot.
<Disadvantages>
(1) The angle of view is fixed. If a workpiece is not viewable in the angle of view, it is required to create a system where the parts supply box or camera head is moved as required.
(2) It is required to create an operation path for the robot to take without interfering with the camera.



■Hand Eye
< Advantages>
(1) The measurement viewpoint can be moved freely with the robot, allowing multiple workpieces to be handled with ease.
(2) A tab longer than that used for fixed cameras can be attached and it is easy to design a layout where interference with the parts supply box will not occur easily.
<Disadvantages>
(1) The robot rests when performing measurement, resulting in slowdown of the pace of work.
(2) The weight of transportable workpieces is limited by the weight of the camera head attachment adapter and the camera head.
(3) The robot posture is restricted because it is necessary to avoid the camera head interference area.

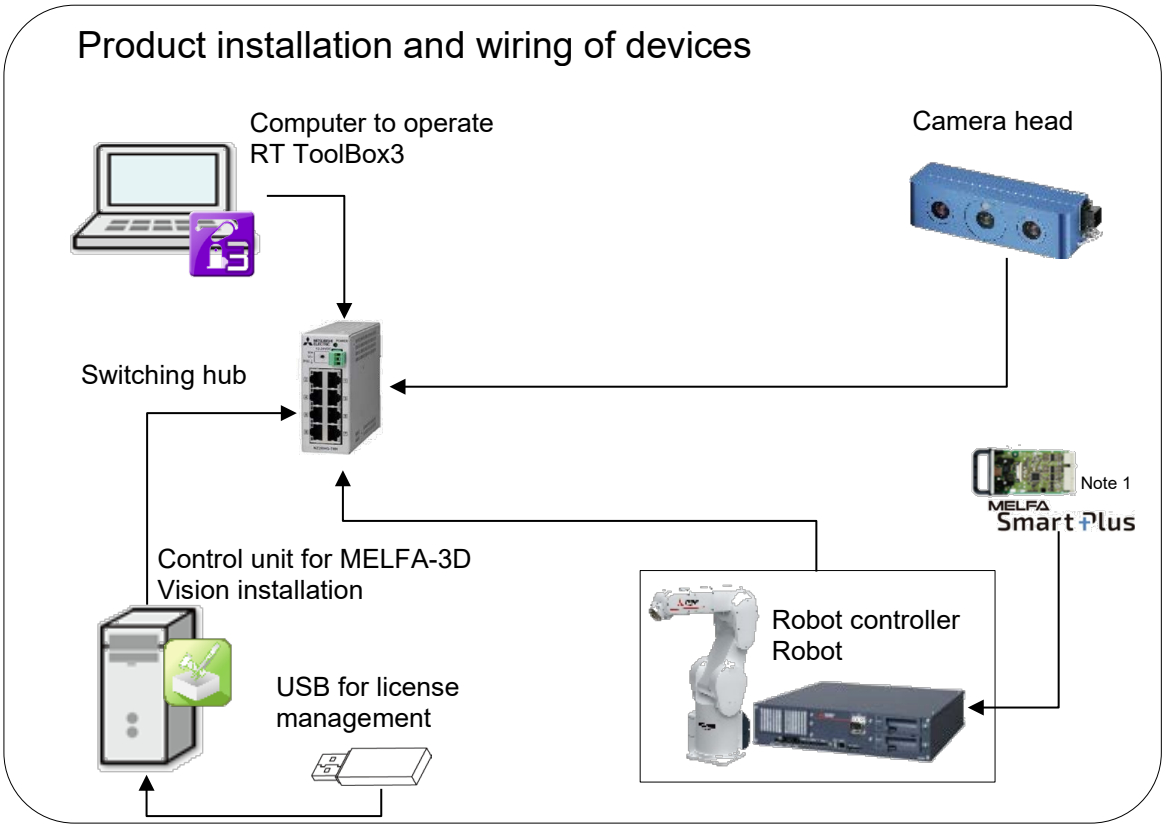


4. USAGE

The position and posture to pick up a desired workpiece can be output by using MELFA-3D Vision 3.0 and configuring settings using the following steps.

1. INSTALLING AND OPERATING THE PRODUCT (Chapter 5)

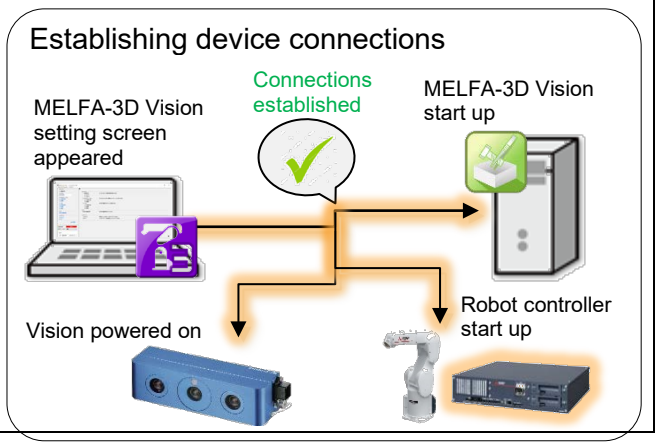
- Plugging the USB dongle for license management into the control unit
- Installing MELFA-3D Vision software on the control unit
- Installing the camera's SDK and driver on the control unit
- Installing RT ToolBox3 on a computer to operate the software
- Attaching the camera to the robot or stand
- Wiring of devices (robot controller, computer to operate RT ToolBox3, control unit, camera, and robot)
- (When using the MELFA-3D Vision extended function) Inserting the MELFA Smart Plus card[Note 1] into the robot controller



Note 1: When the robot controller software version is Ver.E4 or later, extended MELFA-3D Vision functions are available without the MELFA Smart Plus card or the card pack.

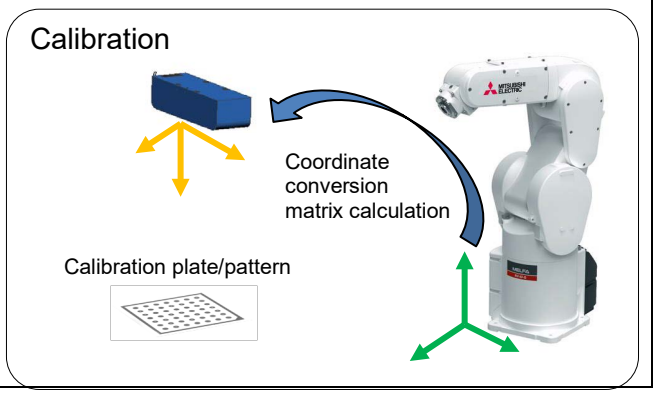
2. DEVICE COMMUNICATION AND CONNECTION SETTINGS (Chapter 6)

- Accessing the MELFA-3D Vision setting screen in RT ToolBox3
- Configuring communication settings of the control unit, camera, and robot on the MELFA-3D Vision setting screen
- Connecting the robot controller using RT ToolBox3



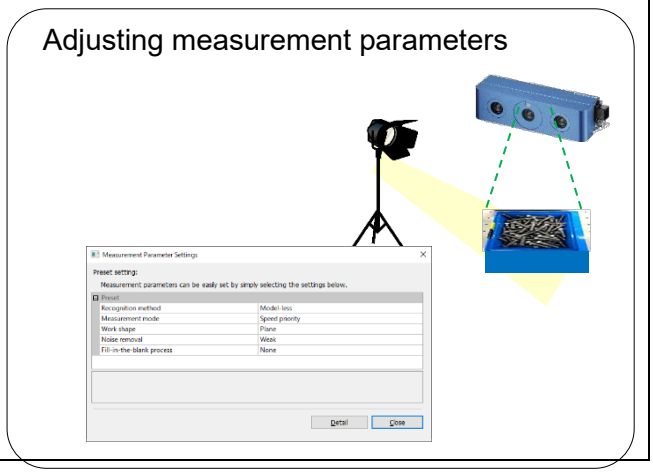
3. CALIBRATION (Chapter 7)

- Placing a calibration plate/pattern
- Calculating the relative position between the vision and robot on the MELFA-3D Vision setting screen



4. Measurement Settings (Section 8.2)

- Placing the workpiece in the desired layout
- Setting the measurement parameters of the workpiece on the MELFA-3D Vision setting screen



5. Recognition settings (Sections 8.3.1 and 8.3.2)

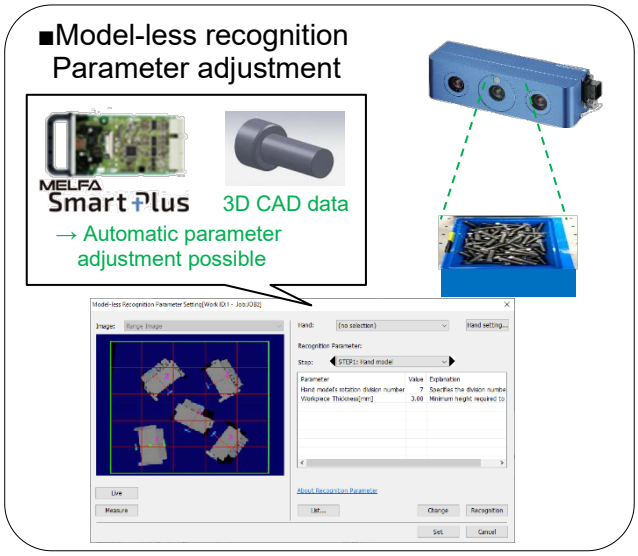
■ Model-less recognition

◇ When using the AI extended function

- Importing a CAD model of the target workpiece as directed on the MELFA-3D Vision setting screen
- Automatically learning recognition parameters from the CAD model with the SmartPlus card inserted into the robot controller

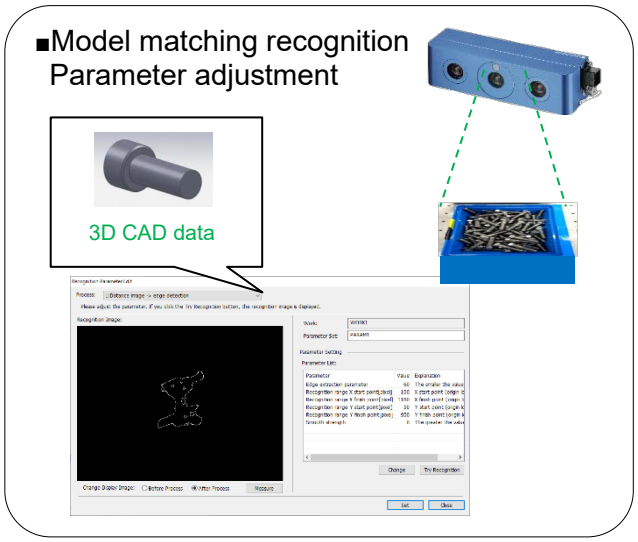
◇ When not using the AI extended function

Manually configuring hand and recognition parameter settings



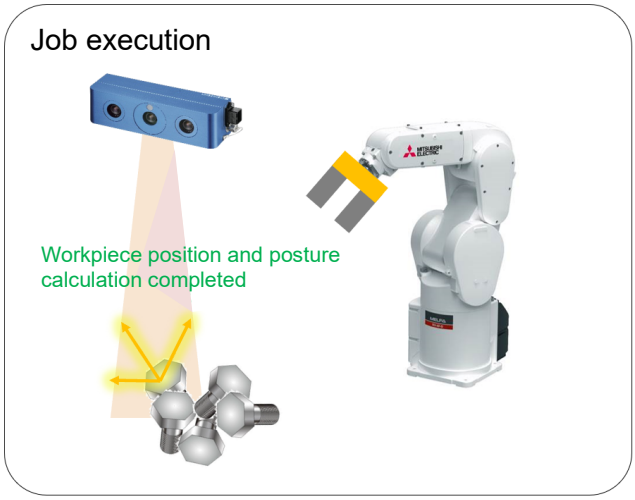
■ Model matching recognition

- Importing a CAD model of the target workpiece as directed on the MELFA-3D Vision setting screen
- Manually configuring hand and recognition parameter settings



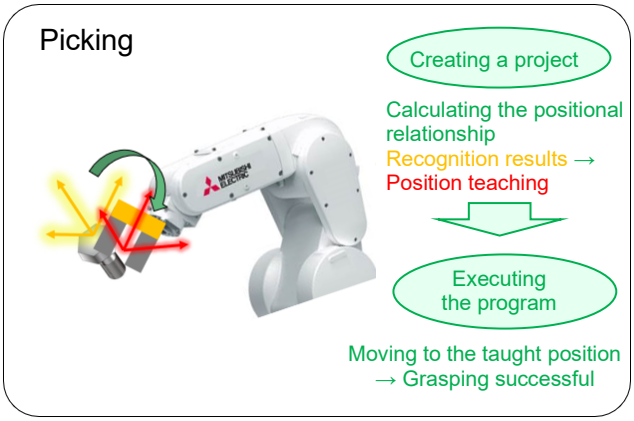
6. Job execution (Section 8.3.3)

- Executing the job (measurement → recognition) using the preset parameters as directed on the MELFA-3D Vision setting screen
- Monitoring the results on the MELFA-3D Vision setting screen



7. PICKING (Chapter 9)

- Creating a robot program to acquire a workpiece recognition point and grasp the workpiece
- (If required) Creating a robot program to convert the workpiece recognition point into the grasp point



5. INSTALLING AND OPERATING THE PRODUCT

5.1. Installation and Wiring of Devices

This section explains the connection of the power cable and grounding wire, and the connection and wiring between the camera head and the control unit and robot controller.

Connect the camera head and robot controller as shown in Fig. 5-1 to Fig. 5-3.

◇◆◇Robot controller connection◇◆◇

If performing measurement and recognition only, there is no need to connect the robot controller. If performing picking work, connect the robot controller.

<CR750-D series>

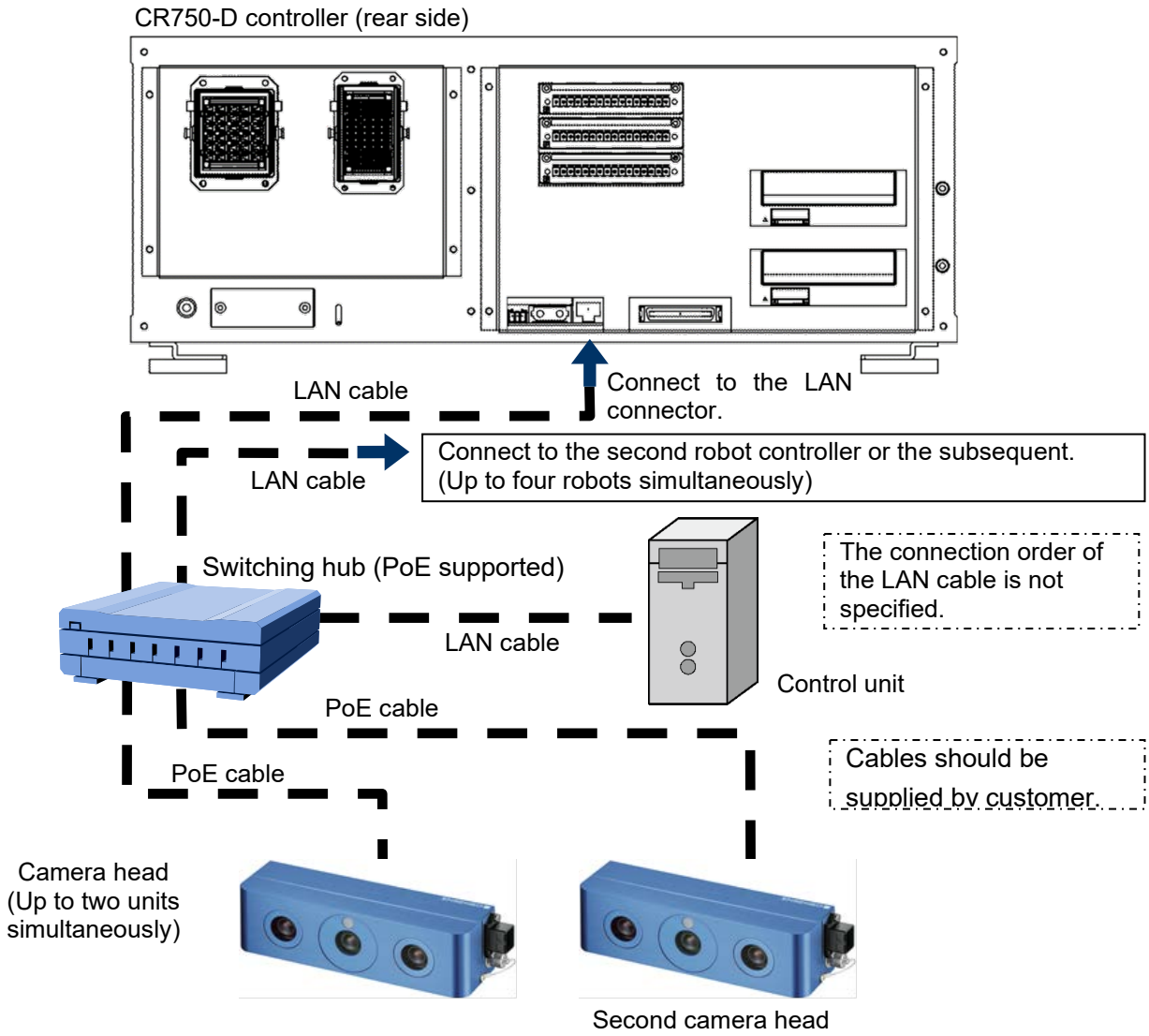


Fig. 5-1 Cable connection (CR750-D series)

<CR751-D series>

CR751-D controller (front side)

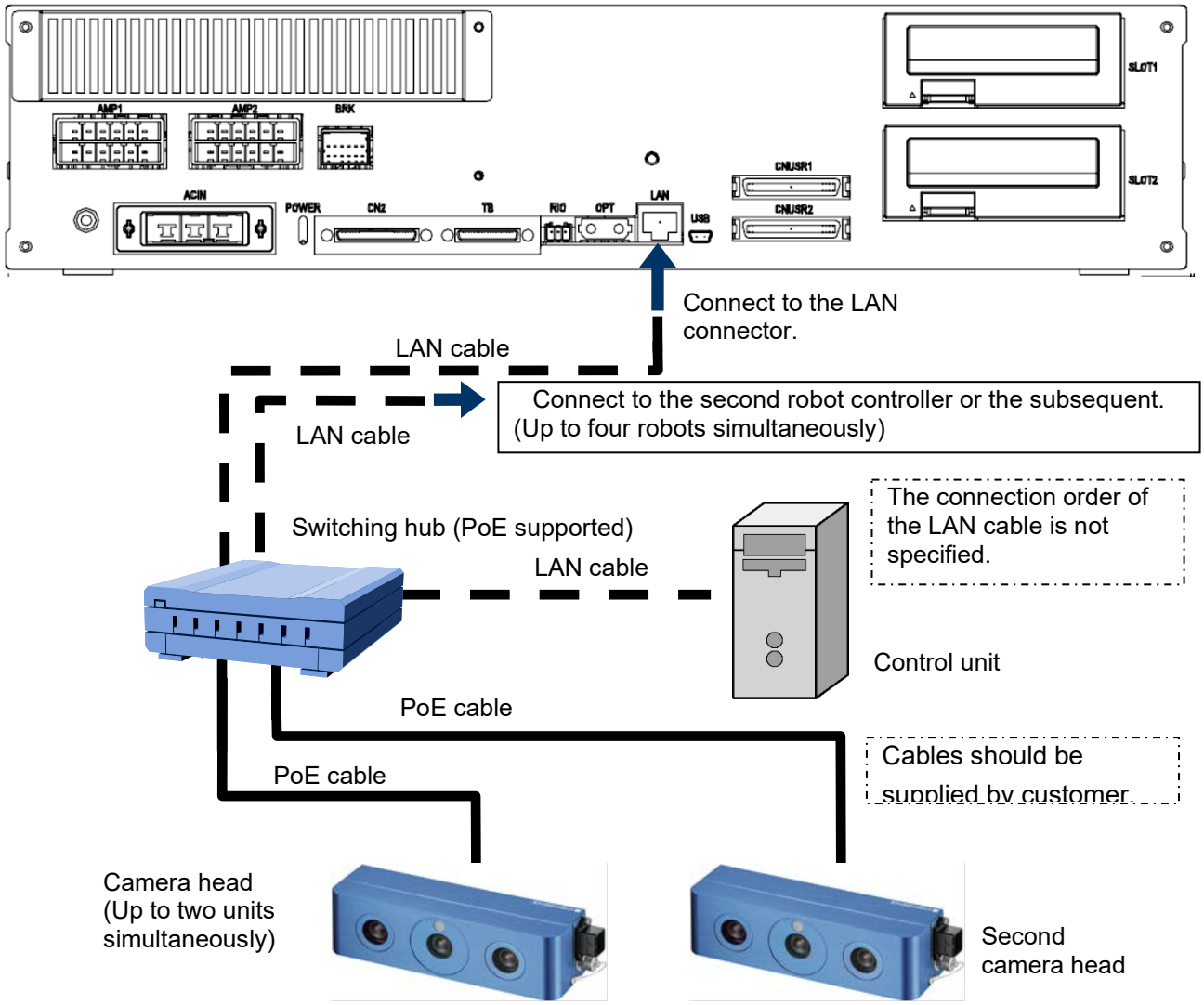


Fig. 5-2 Cable connection (CR751-D series)

<CR800-Q/CR750-Q/CR751-Q series>

Robot CPU unit

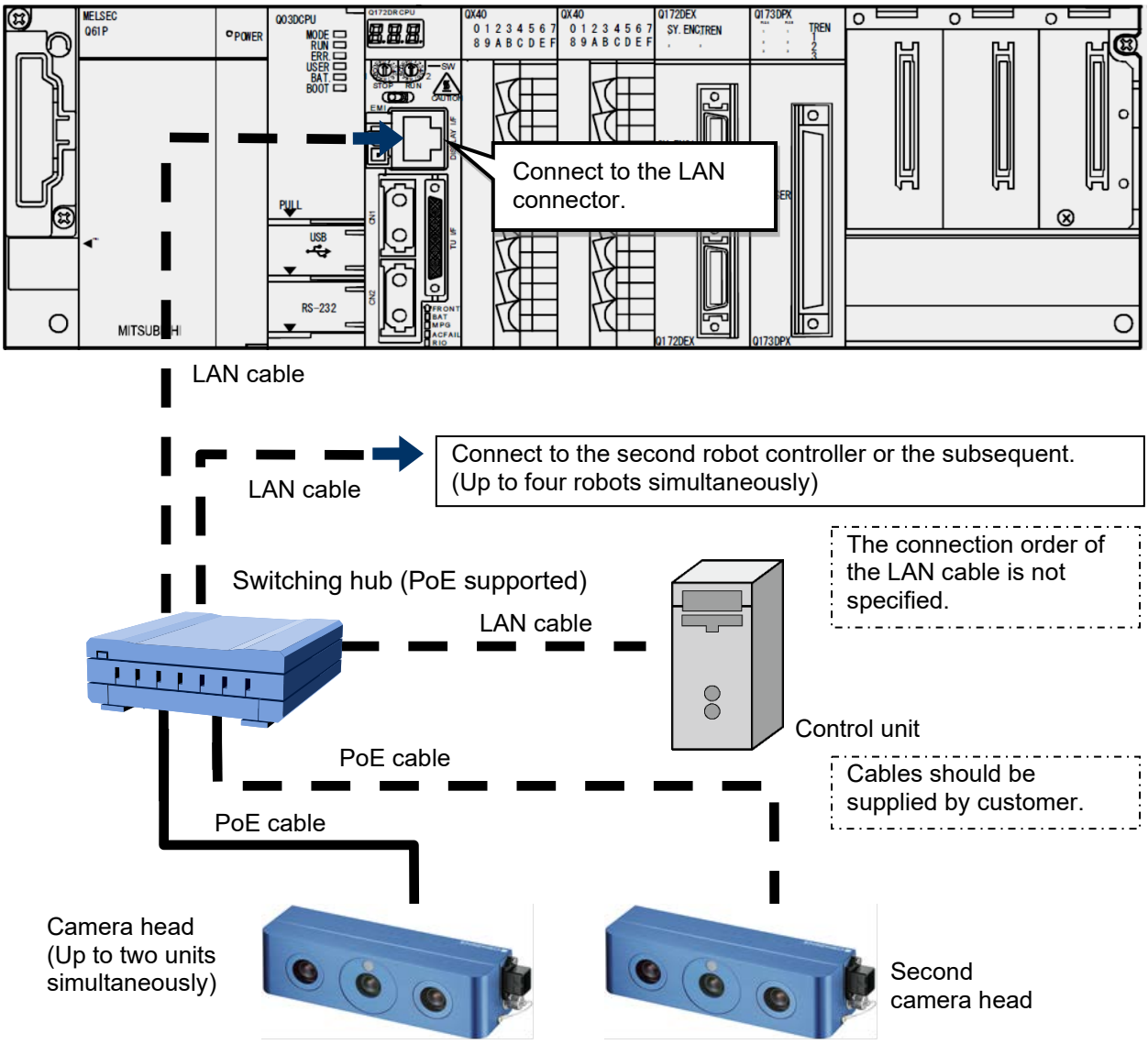


Fig. 5-3 Cable connection (CR800-Q/CR750-Q/CR751-Q series)

<CR800-D>

CR800-D controller (front side)

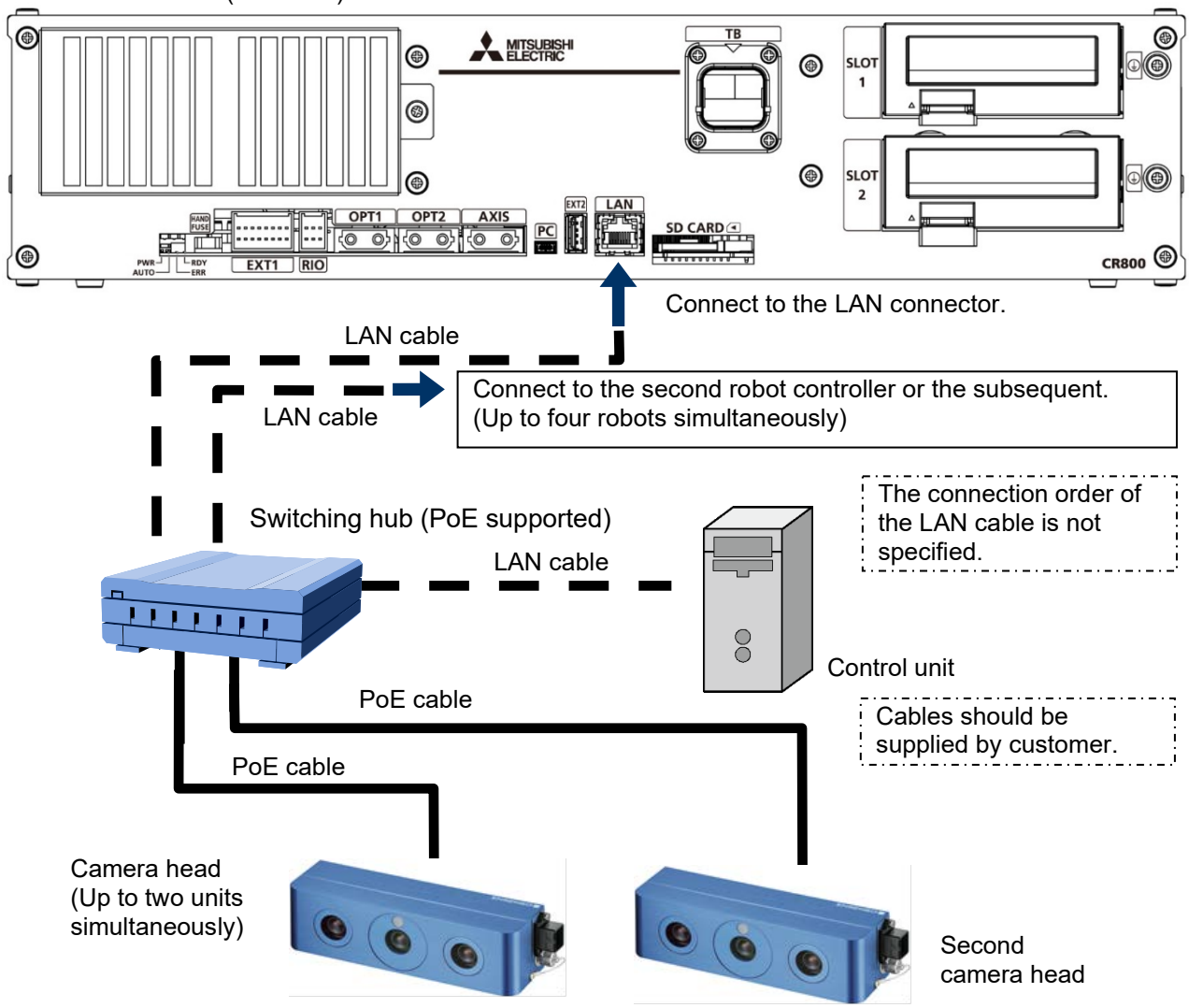


Fig. 5-4 Cable connection (CR800-D)

<CR860-D>

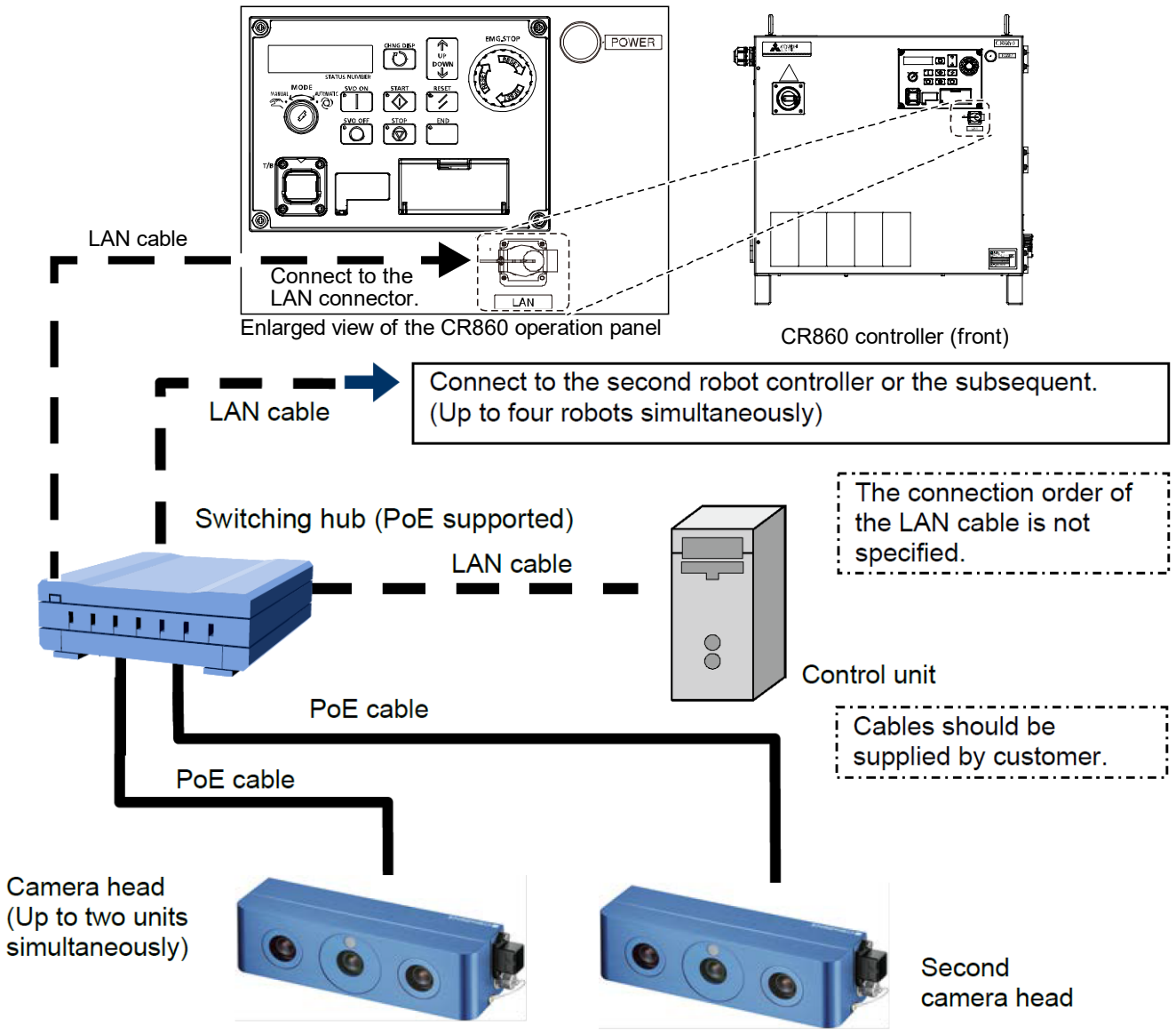


Fig. 5-5 Cable connection (CR860-D)

<CR800-R series>

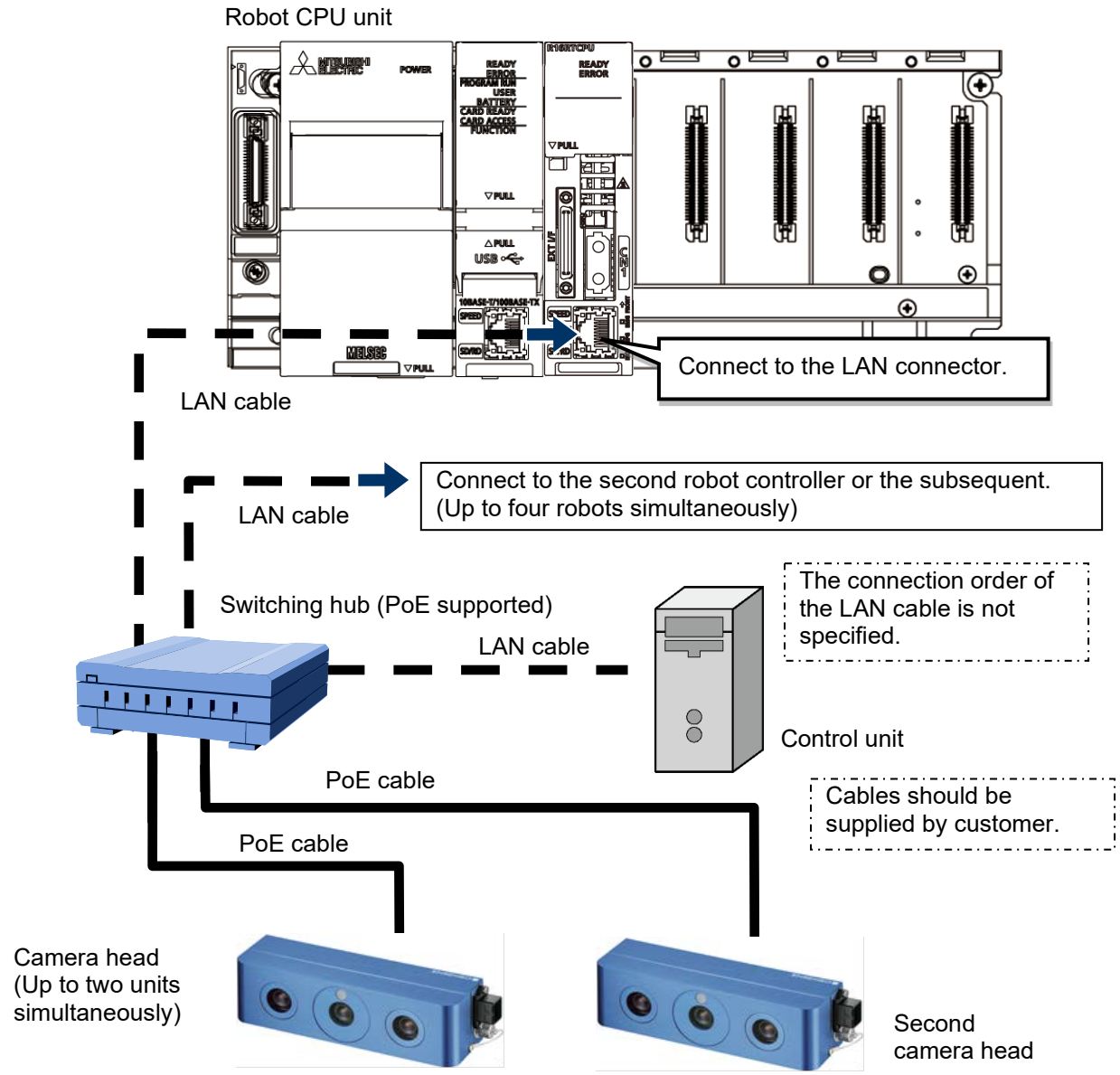


Fig. 5-6 Cable connection (CR800-R series)

5.1.1. Camera installation

Connect the control unit and camera head as shown in the following figure.
When not using a MELFA-3D Vision-compatible PoE cable (refer to "3.2 Items to be Prepared by Customer"), use another PoE cable or an ENSENSO power cable and Ethernet cable.
MELFA-3D Vision-compatible PoE cables (refer to "3.2 Items to be Prepared by Customer") are not compatible with internal wiring.

■ Hand eye
Secure the power cable and dedicated communication cable (between the control unit and camera head) to the outer surface of the robot arm. When doing so, secure so that the cable is not stretched when the robot moves.
A jig to attach the camera head to the robot should be supplied by customer. (Refer to "7.2.4 Non-contact type (hand eye)".)
Before attaching the camera and jig, enable the interlock and select MANUAL mode. Ensure that the robot and hand do not interfere with surrounding objects.

Fig. 5-7 Example of wiring when a hand eye is used

■ Fixed camera
Secure the power cable and dedicated communication cable (between the control unit and camera head) to the stand.
Ensure that the cables are not stretched when the robot moves. A camera head stand should be supplied by customer.
For fixed cameras, a jig to attach a calibration plate/pattern to the robot should be supplied by customer for calibration. (Refer to "7.2.5 Non-contact type (fixed camera)".)
Before attaching the camera and jig, enable the interlock and select MANUAL mode. Ensure that the robot and hand do not interfere with surrounding objects.

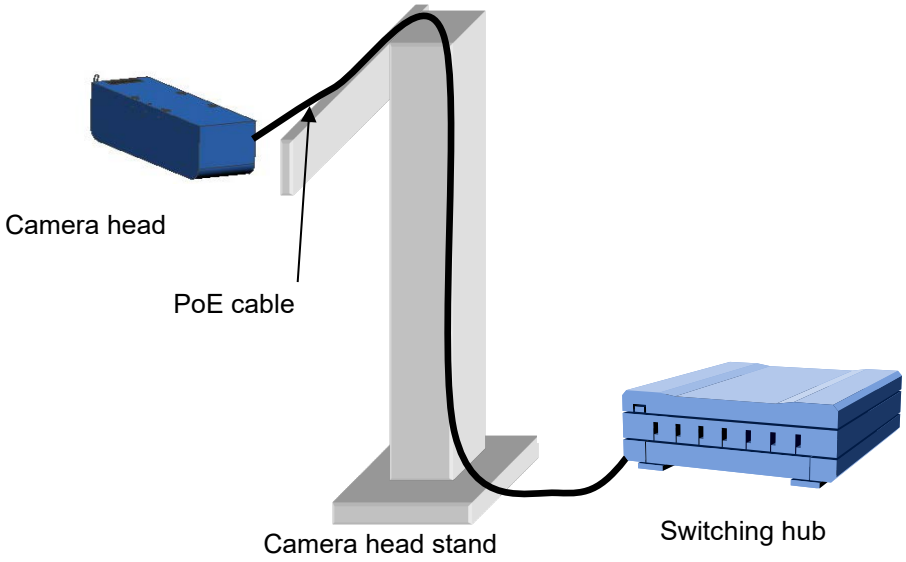


Fig. 5-8 Example of wiring when a fixed camera is used

5.2. When Using the MELFA-3D Vision Extended Function

When using the extended functions such as automatic adjustment of the recognition setting, insert the MELFA Smart Plus card or Smart Plus card pack into the robot controller, and set the parameters and function codes. (CR800 controller use only)
Recognition parameter automatic adjustment AI is available for the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR.
It is not available for the MELFA ASSISTA series.

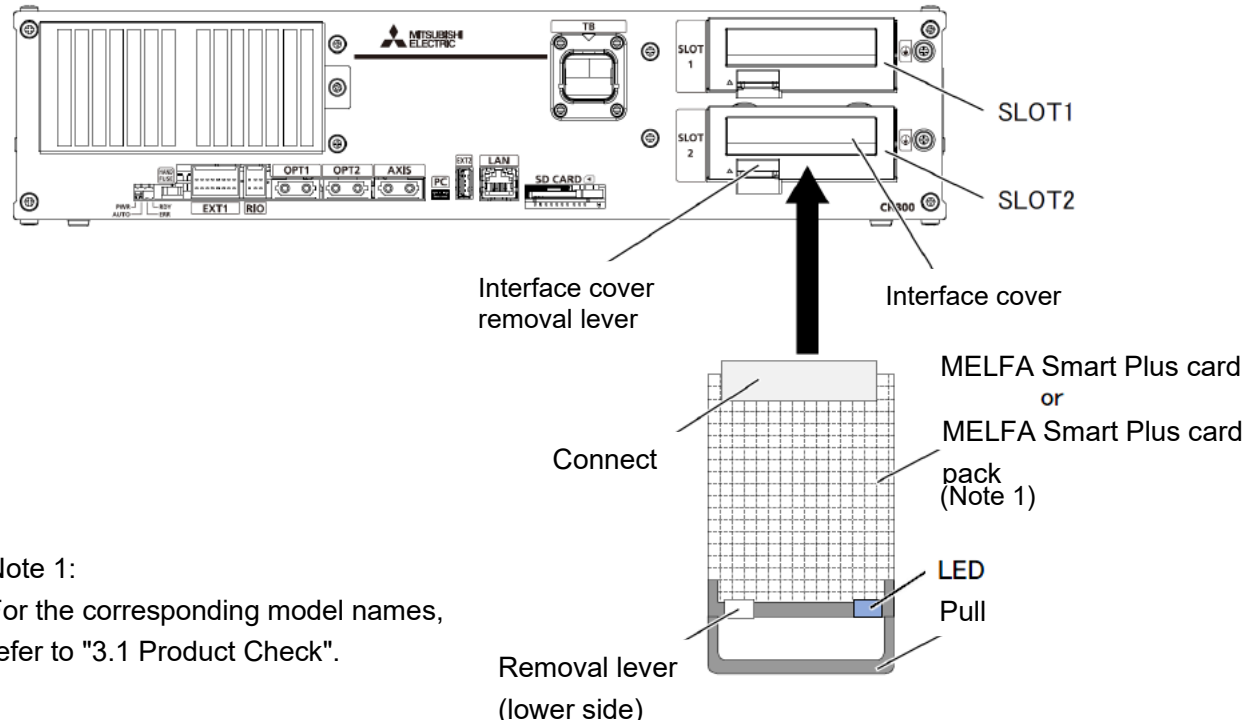
CAUTION

The MELFA-3D Vision extended functions cannot be used in the CR750/CR751/CR860 series controllers.

【When the robot controller software version is Ver.E4 or later】
When the robot controller software version is Ver.E4 or later, extended MELFA-3D Vision functions are available without the MELFA Smart Plus card or the card pack.
Steps 1 through 4 are not required.
Proceed to step 5.

1. Turn OFF the robot controller power.
   - CR800-D type : (1) Turn OFF the earth leakage breaker switch.
   - CR800-R/Q type : (1) Turn OFF the robot CPU system power.
     (2) Turn OFF the earth leakage breaker switch.

2. Insert the "MELFA Smart Plus card" or "MELFA Smart Plus card pack" into the robot controller. (For the corresponding model names, refer to "3.1 Product Check".)
   (1) Pinch the interface cover removal lever and pull out the interface cover.
   (2) Hold the pull of the MELFA Smart Plus card and insert it into SLOT1 or SLOT2.
   At this time, insert the card so that the both ends of the card fit into the grooves of the slot (SLOT1 and SLOT2 in Fig. 5-9).
   (3) Insert the connector fully into the slot until the removal lever is locked with clicking sound.



Note 1:
For the corresponding model names, refer to "3.1 Product Check".

Fig. 5-9 Insertion of the MELFA Smart Plus card (MELFA Smart Plus card pack)

⚠ CAUTION

Insert only one MELFA Smart Plus card.
When multiple MELFA Smart Plus cards are inserted, the LED does not blink, and the error (L3782) occurs.
For the error details, refer to "14.3 MELFA Smart Plus Card Related Error Details".

3. Turn ON the robot controller power.

- CR800-D type : (1) Turn ON the earth leakage breaker switch.
  (The POWER lamp of the robot controller blinks. After startup, the lamp stays ON.)
- CR800-R/Q type : (1) Turn ON the earth leakage breaker switch.
  (The POWER lamp of the robot controller blinks. After startup, the lamp stays ON.)
  (2) After that, turn ON the robot CPU system power.

4. For the MELFA Smart Plus card, set the parameters for enabling MELFA-3D Vision.

■ When using the MELFA Smart Plus card
Only one function supported by the card used can be used. Therefore, setting the parameters for enabling MELFA Smart Plus and MELFA-3D Vision and restarting the robot controller are not required.
Use the teaching pendant or RT ToolBox3 to set the parameters.
When using RT ToolBox3, connect RT ToolBox3 to the controller using MELFA-3D Vision.

(1) Change the setting value of the parameter "SMART+1" to [101].

(2) Restart the robot controller.

- CR800-D type : Turn ON the earth leakage breaker switch.
- CR800-R/Q type : Turn OFF the robot CPU system power.
  →Turn OFF the earth leakage breaker switch.
  →Turn ON the earth leakage breaker switch.
  →Turn ON the robot CPU system power after the POWER lamp of the robot controller blinks.

(3) The LED blinks in green when MELFA-3D Vision is enabled. (near the card handle,”Fig. 5-9 Insertion of the MELFA Smart Plus card (MELFA Smart Plus card pack)”）。

■ When using the MELFA Smart Plus card pack]

- It is not required to configure these settings and restart the robot controller. Continue to Step 5.
- Check that the LED of the MELFA Smart Plus card pack blinks in blue.

5. Set the function code of the MELFA Smart Plus card.

When the RT ToolBox3 version is Ver.2.70Y or later, the function code setting is not required.

Proceed to section 5.3.

■ When setting the function code for RT ToolBox3 connected to the actual device

(1) Start RT ToolBox3 and connect it to the actual device.

(2) Select [Option] in the [Workspace] tab in RT ToolBox3.

(3) Select [MELFA Smart Plus] from the tree on the left of the Option window.

(4) When the "Get function code" button is pressed, the function code of the MELFA Smart Plus card is input in the function code column.

(5) Restart RT ToolBox3.

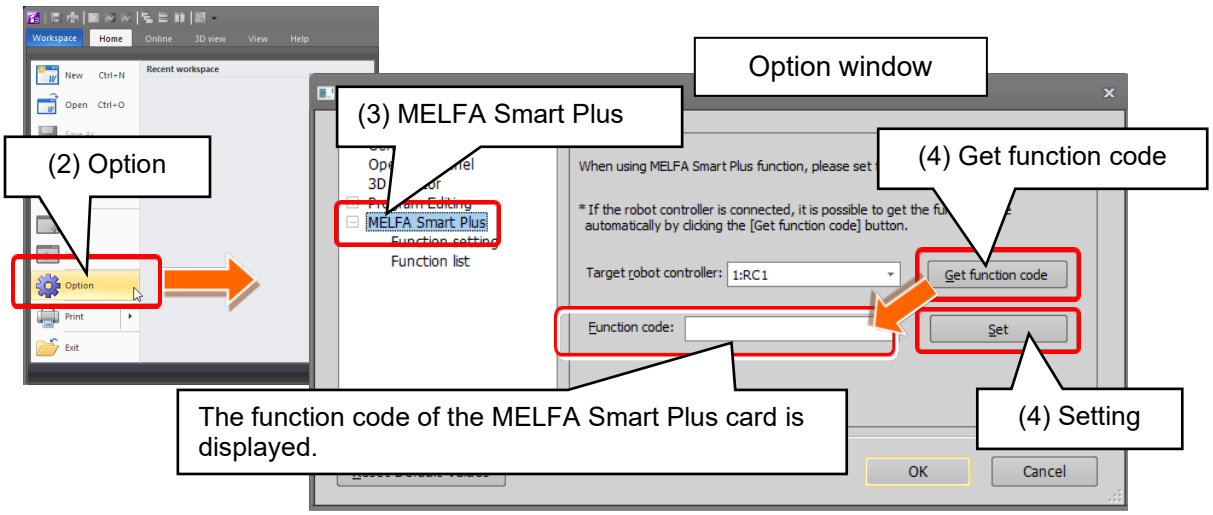


Fig. 5-10 Function code setting of the MELFA Smart Plus card (when connected to the actual device)

■ When setting the function code for RT ToolBox3 not connected to the actual device

(1) Read the value of the parameter "MSPCODE" with the teaching pendant or RT ToolBox3 connected to the actual device. (The value of "MSPCODE" is the function code. It is not displayed when the MELFA Smart Plus card is not inserted.)

(2) Note the displayed value of the parameter "MSPCODE" (24 alphanumeric characters).

(3) In RT ToolBox3 not connected to the actual device, select [Option] in the [Workspace] tab.

Select [MELFA Smart Plus] from the tree on the left of the Option window.

(4) Input the function code of the MELFA Smart Plus card obtained at "Step 2" in the "Function code" column and press the Set button.

(5) Restart RT ToolBox3.

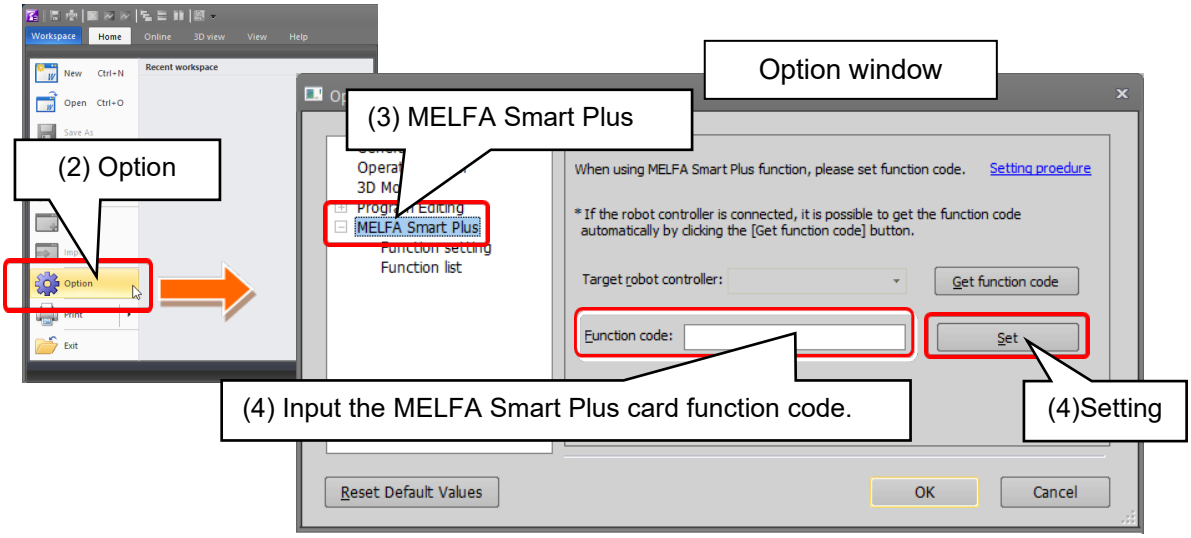


Fig. 5-11 Function code setting of the MELFA Smart Plus card (when not connected to the actual device)

6. Check that MELFA-3D Vision is enabled.

(1) Select [MELFA Smart Plus] - [Function list] from the tree on the left of the Option window.

(2) The list of valid status of the MELFA Smart Plus functions is displayed on the right.
Check that the state of "Extended function of MELFA-3D Vision" is set to "Enable".

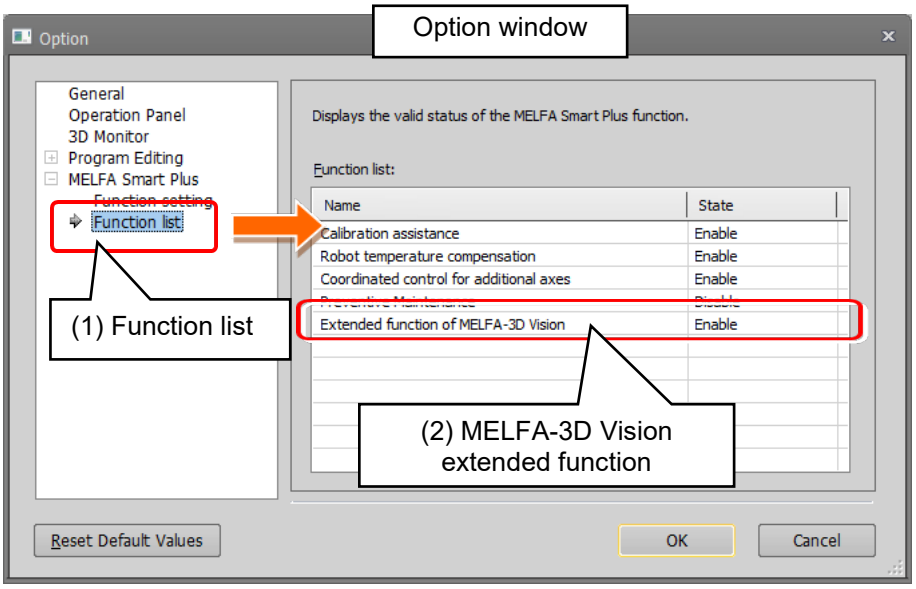


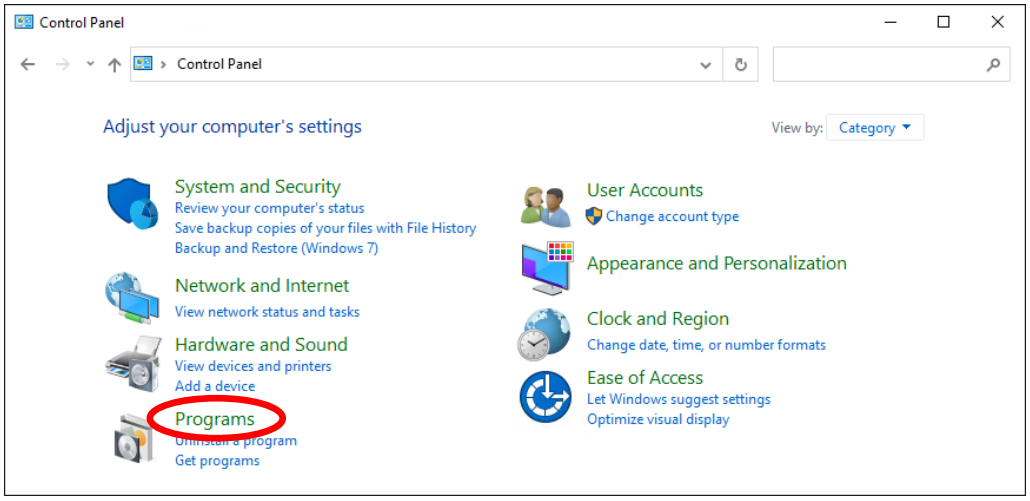
Fig. 5-12 Checking the state of the MELFA-3D Vision extended function

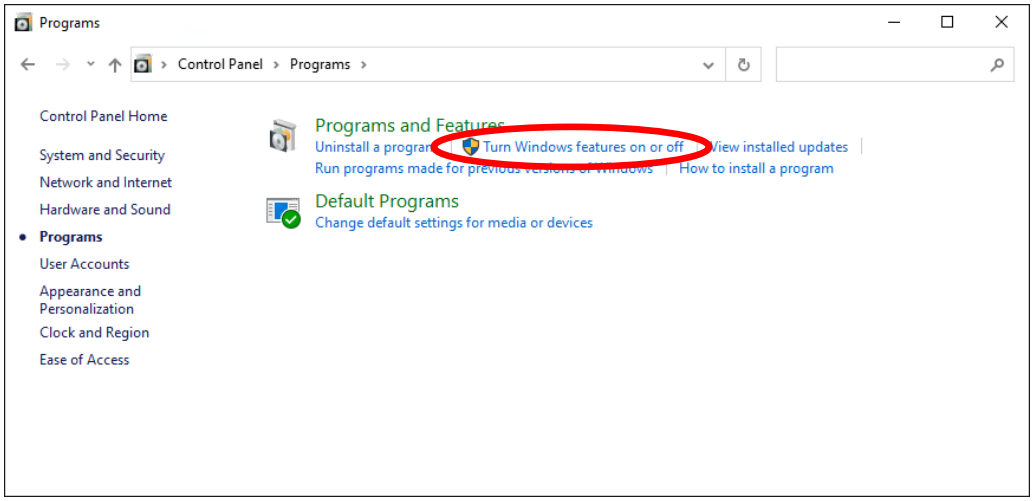
5.3. MELFA-3D Vision software installation procedure

Install this software on the control unit with the procedure below. The SDK and uEye are also installed.

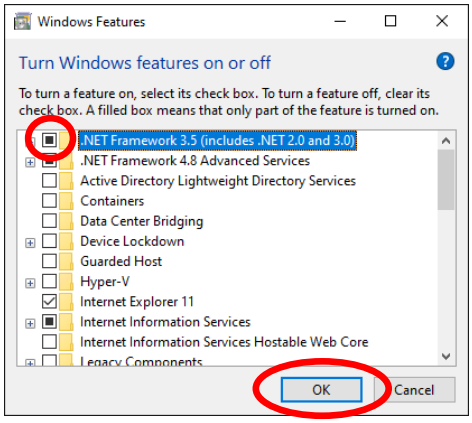
5.3.1. Notes of when RT ToolBox3 is installed

When you install this software on Windows 10, you will need to turn on the ".NET Framework Version 3.5 (includes .NET 2.0 and 3.0)" feature of the PC you want to install. Attempting to install the software without enabling ".NET Framework 3.5 (includes .NET 2.0 and 3.0)" will not complete the installation.
In this case, install the software again after enabling ".NET Framework 3.5 (includes .NET 2.0 and 3.0)" using the following steps.
Be ready to connect the PC to the Internet.
Select [Programs] – [Turn Windows features on or off] from the Control Panel.

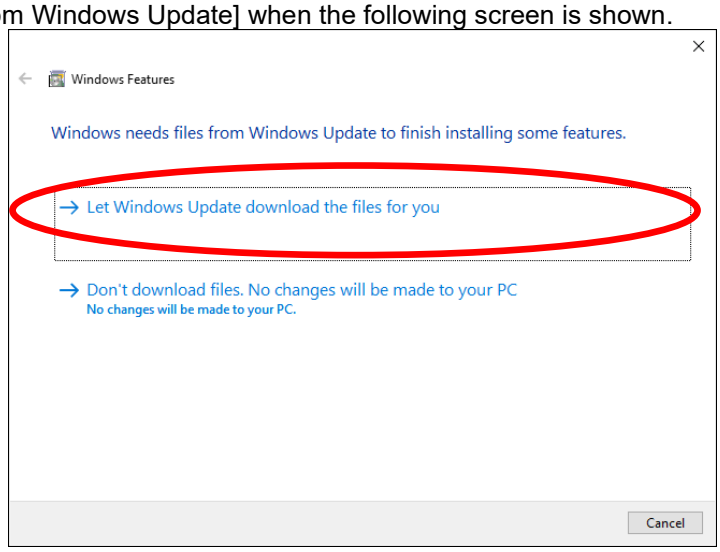




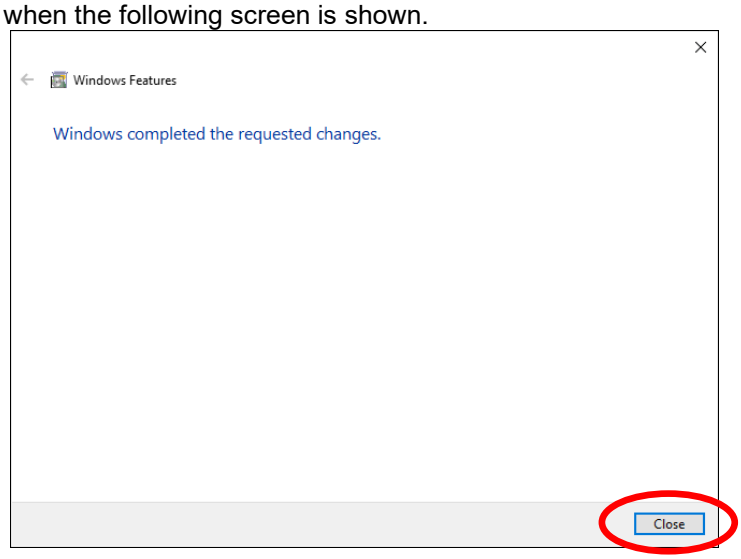
Check the [.NET Framework 3.5 (includes .NET 2.0 and 3.0)] check box on the Turn Windows features on or off screen and click [OK].



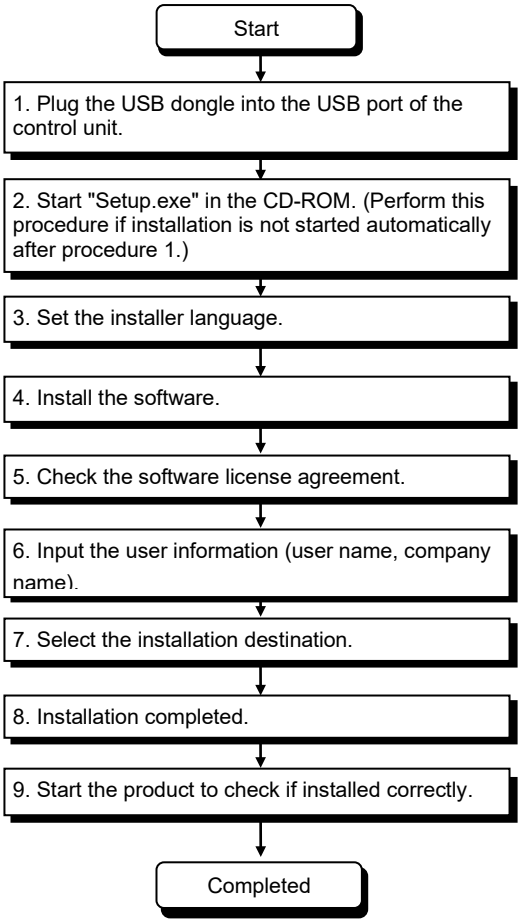
Select [Download files from Windows Update] when the following screen is shown.



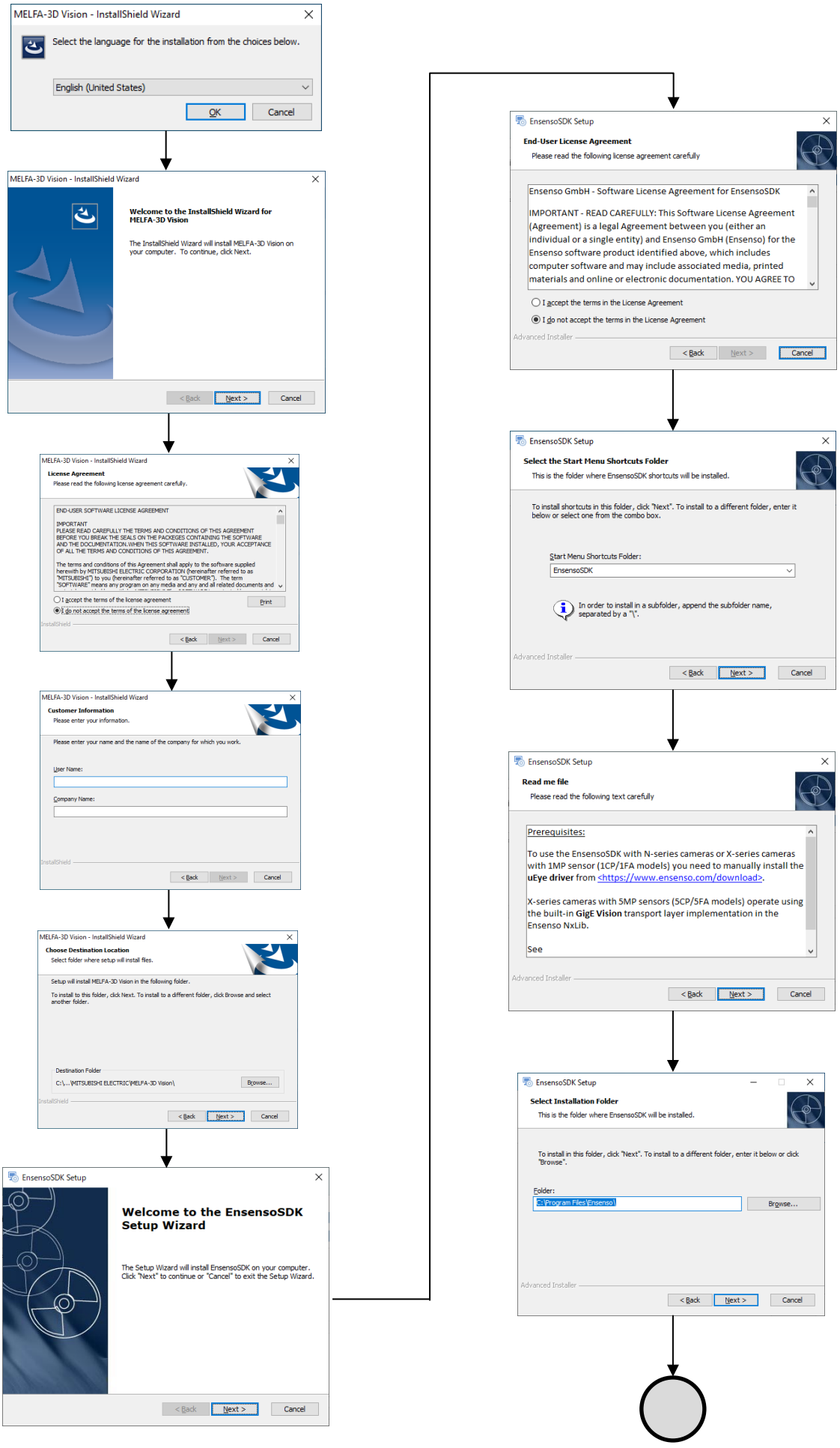
This process is complete when the following screen is shown.

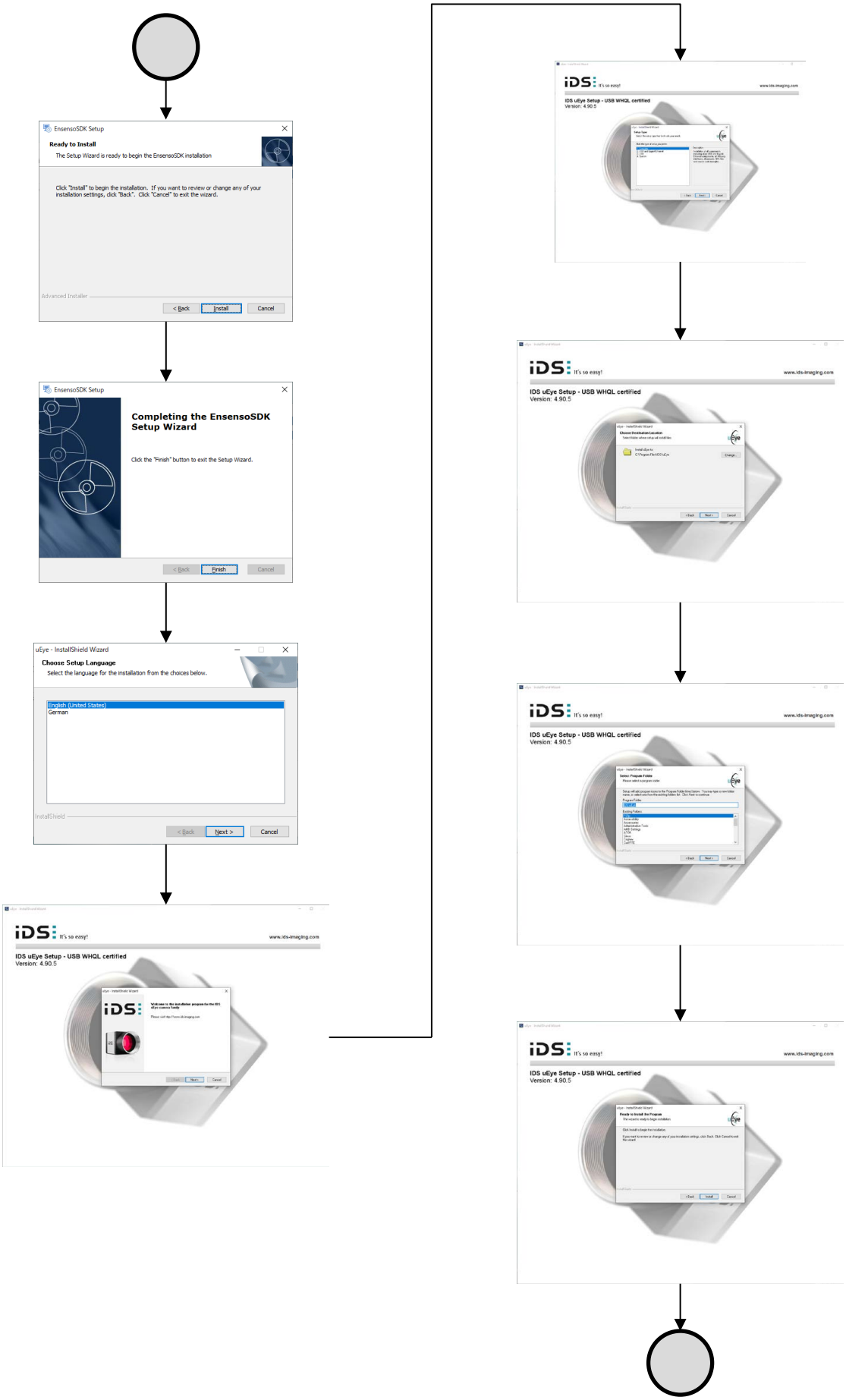


5.3.2. Installation procedure



Screen images with the following versions are used in this manual.
SDK ver.: 2.3.1536
uEye ver.: 4.93


MELFA-3D Vision - InstallShield Wizard
Select the language for the installation from the choices below.
English (United States)
OK
Cancel
MELFA-3D Vision - InstallShield Wizard
Welcome to the InstallShield Wizard for MELFA-3D Vision
The InstallShield Wizard will install MELFA-3D Vision on your computer. To continue, click Next.
< Back
Next >
Cancel
MELFA-3D Vision - InstallShield Wizard
License Agreement
Please read the following license agreement carefully.
END-USER SOFTWARE LICENSE AGREEMENT
IMPORTANT
PLEASE READ CAREFULLY THE TERMS AND CONDITIONS OF THIS AGREEMENT BEFORE YOU BREAK THE SEALS ON THE PACKEGES CONTAINING THE SOFTWARE AND THE DOCUMENTATION. WHEN THIS SOFTWARE INSTALLED, YOUR ACCEPTANCE OF ALL THE TERMS AND CONDITIONS OF THIS AGREEMENT.
The terms and conditions of this Agreement shall apply to the software supplied herewith by MITSUBISHI ELECTRIC CORPORATION (hereinafter referred to as "MITSUBISHI") to you (hereinafter referred to as "CUSTOMER"). The term "SOFTWARE" means any program on any media and any and all related documents and
I accept the terms of the license agreement
I do not accept the terms of the license agreement
Print
InstallShield
< Back
Next >
Cancel
MELFA-3D Vision - InstallShield Wizard
Customer Information
Please enter your information.
Please enter your name and the name of the company for which you work.
User Name:
Company Name:
InstallShield
< Back
Next >
Cancel
MELFA-3D Vision - InstallShield Wizard
Choose Destination Location
Select folder where setup will install files.
Setup will install MELFA-3D Vision in the following folder.
To install to this folder, click Next. To install to a different folder, click Browse and select another folder.
Destination Folder
C:\...\MITSUBISHI ELECTRIC\MELFA-3D Vision\
Browse...
InstallShield
< Back
Next >
Cancel
EnsensoSDK Setup
Welcome to the EnsensoSDK Setup Wizard
The Setup Wizard will install EnsensoSDK on your computer. Click "Next" to continue or "Cancel" to exit the Setup Wizard.
< Back
Next >
Cancel
EnsensoSDK Setup
End-User License Agreement
Please read the following license agreement carefully
Ensenso GmbH - Software License Agreement for EnsensoSDK
IMPORTANT - READ CAREFULLY: This Software License Agreement (Agreement) is a legal Agreement between you (either an individual or a single entity) and Ensenso GmbH (Ensenso) for the Ensenso software product identified above, which includes computer software and may include associated media, printed materials and online or electronic documentation. YOU AGREE TO
I accept the terms in the License Agreement
I do not accept the terms in the License Agreement
Advanced Installer
< Back
Next >
Cancel
EnsensoSDK Setup
Select the Start Menu Shortcuts Folder
This is the folder where EnsensoSDK shortcuts will be installed.
To install shortcuts in this folder, click "Next". To install to a different folder, enter it below or select one from the combo box.
Start Menu Shortcuts Folder:
EnsensoSDK
In order to install in a subfolder, append the subfolder name, separated by a "\".
Advanced Installer
< Back
Next >
Cancel
EnsensoSDK Setup
Read me file
Please read the following text carefully
Prerequisites:
To use the EnsensoSDK with N-series cameras or X-series cameras with 1MP sensor (1CP/1FA models) you need to manually install the uEye driver from <https://www.ensenso.com/download>.
X-series cameras with 5MP sensors (5CP/5FA models) operate using the built-in GigE Vision transport layer implementation in the Ensenso NxLib.
See
Advanced Installer
< Back
Next >
Cancel
EnsensoSDK Setup
Select Installation Folder
This is the folder where EnsensoSDK will be installed.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:\Program Files\Ensenso\
Browse...
Advanced Installer
< Back
Next >
Cancel


EnsensoSDK Setup
Ready to Install
The Setup Wizard is ready to begin the EnsensoSDK installation
Click "Install" to begin the installation. If you want to review or change any of your installation settings, click "Back". Click "Cancel" to exit the wizard.
Advanced Installer
< Back
Install
Cancel
EnsensoSDK Setup
Completing the EnsensoSDK Setup Wizard
Click the "Finish" button to exit the Setup Wizard.
< Back
Finish
Cancel
uEye - InstallShield Wizard
Choose Setup Language
Select the language for the installation from the choices below.
English (United States)
German
InstallShield
< Back
Next >
Cancel
iDS: It's so easy!
www.ids-imaging.com
IDS uEye Setup - USB WHQL certified
Version: 4.90.5

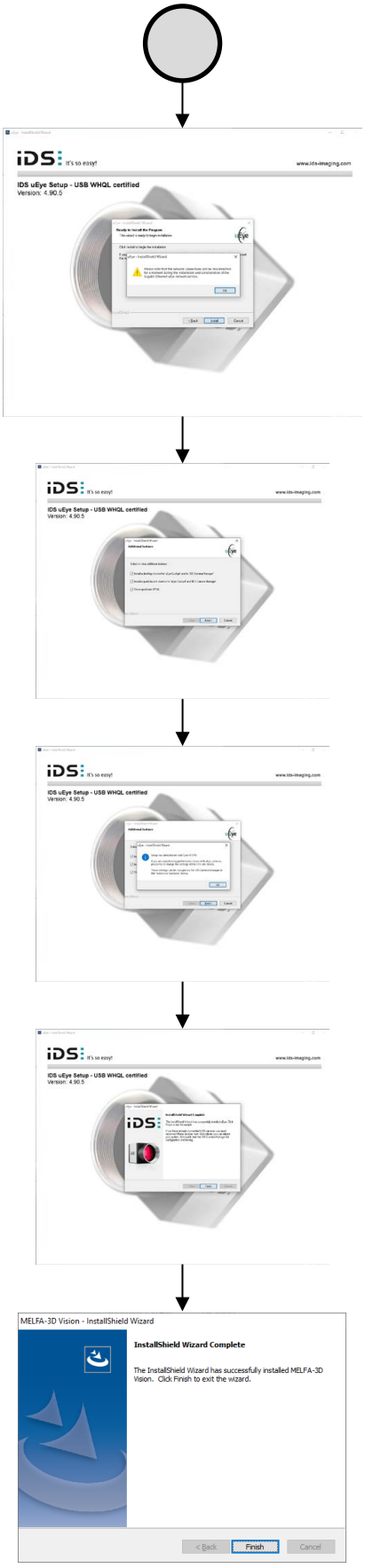


Fig. 5-13 MELFA-3D Vision software installation

5.4. IP Address Preparation

One IP address is required for the control unit and camera head individually. If connecting to a network, contact the network administrator beforehand to obtain IP addresses.

5.5. Turning ON the Camera Head

Connect the PoE cable to the camera head and turn ON the camera head.

5.6. Plugging the License USB Dongle

Plug the license USB dongle into the USB port of the control unit before starting the MELFA-3D Vision software. License authentication is required to use MELFA-3D Vision. Leave the USB dongle plugged into the control unit during use. If license authentication fails, communication with the control unit will not be established. The message shown below will appear.

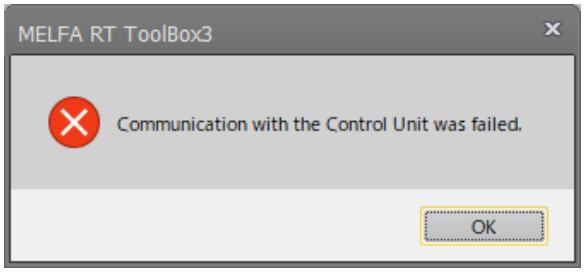


Fig. 5-14 Communication error with the control unit

5.7. MELFA-3D Vision Application Startup

Select the [Start] button → [MITSUBISHI ELECTRIC] → [MELFA-3D Vision] to start the application.
MELFA-3D Vision is stored in the task tray after startup.

Fig. 5-15 MELFA-3D Vision application startup method

5.8. RT ToolBox3 Startup

RT ToolBox3 is required to specify MELFA-3D Vision settings. Double-click the desktop shortcut to start RT ToolBox3, or click the [Start] button, and select [All programs] - [MELSOFT] - [RT ToolBox3].

Fig. 5-16 RT ToolBox3 shortcut

6. DEVICE COMMUNICATION AND CONNECTION SETTINGS

This chapter explains the connection of the control unit, robot, and computer to operate RT ToolBox3.
Configure settings by using the two tools shown below.

■ RT ToolBox3
- Connection to the control unit.
- Robot communication settings (for the control unit and camera).

■ MELFA-3D Vision setting screen (accessed from RT ToolBox3)
Control unit's communication settings (for the robot and camera).
The control unit and RT ToolBox3 can be operated with one computer.

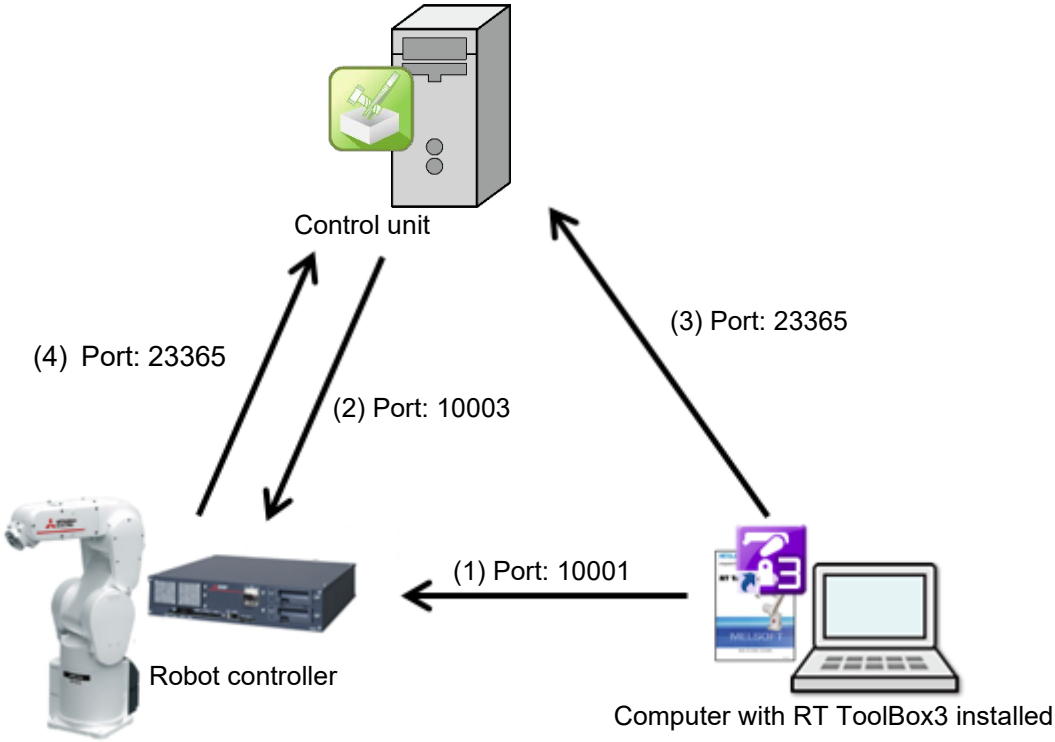


Fig. 6-1 Relationships among port numbers

6.1. RT ToolBox3 Settings

6.1.1. Connection to the control unit

■ Control unit setting/addition screen display
Specify communication settings for the control unit used and add to the workspace. By creating a workspace at RT ToolBox3, [MELFA-3D Vision] appears in the project tree. By pointing [MELFA-3D Vision], [Control unit setting/addition] appears. Double-click this item.

The devices on the network will be listed on the Setting and Add Control Unit screen. If no control unit is listed, check the connection with the computer and the firewall settings (Refer to No.1 in "14.5 Q&A".). Additionally, the connection with an unlisted control unit can be established as long as the IP address is known.

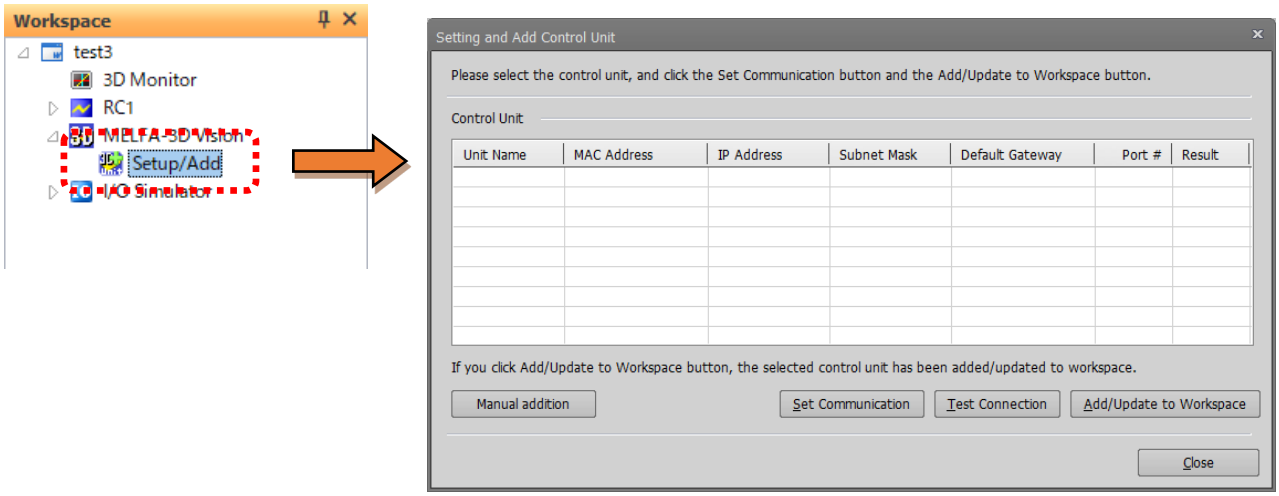


Fig. 6-2 Setting/registration of the control unit

There are three methods for setting and adding the control units.
(1) When connecting to the control unit displayed on the window
(2) When connecting to the control unit whose IP address is determined, which is not displayed in the list
(3) When performing the communication settings of the control unit

(1) When connecting to the control unit displayed on the window

■ Adding a control unit to the workspace

Select the control unit to be added from the list, and then click the [Add/Update to Workspace] button to add the selected control unit to the workspace.

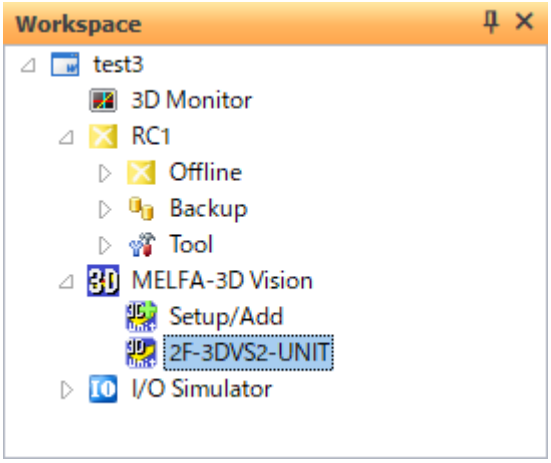


Fig. 6-3 Addition the control unit to the workspace

(2) When connecting to the control unit whose IP address is determined, which is not displayed in the list

The following shows the procedure for registering the settings (unit name/IP address/port number) to the workspace.

■ Control unit communication settings

1. Clicking the [Manual addition] button in the Setting and Add Control Unit window displays the [Control Unit Adding] window.

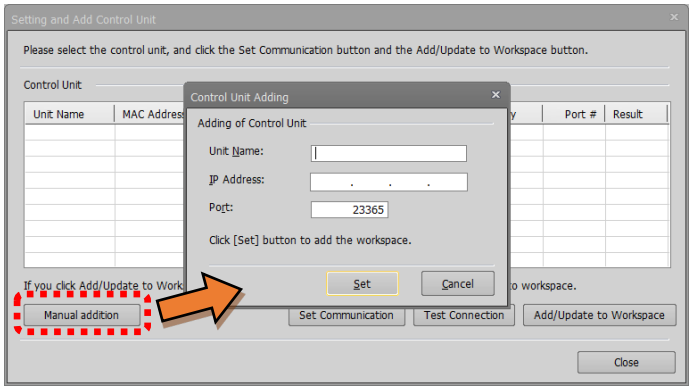


Fig. 6-4 MELFA-3D Vision Setting Screen

2. Input the unit name and IP address.

Since "23365" is input as an initial value for port number. Press the [Set] button as is.

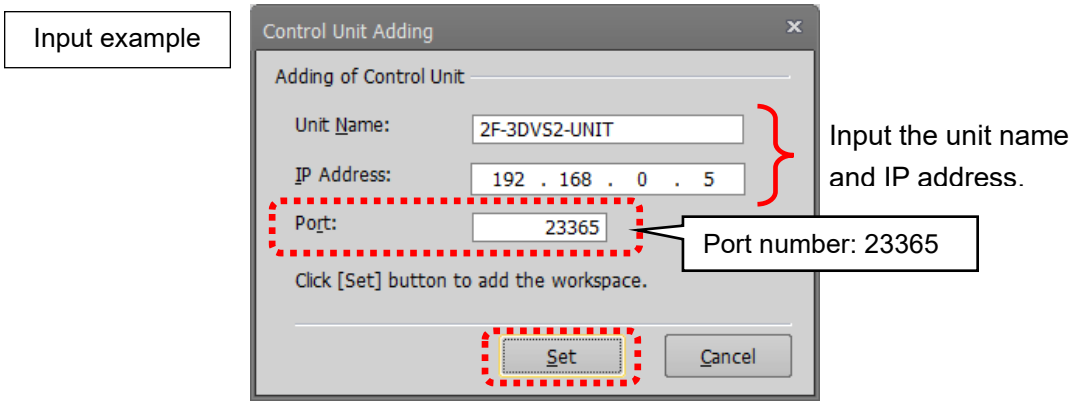


Fig. 6-5 MELFA-3D Vision Setting Screen

The set unit name is added to the project tree of RT ToolBox3.

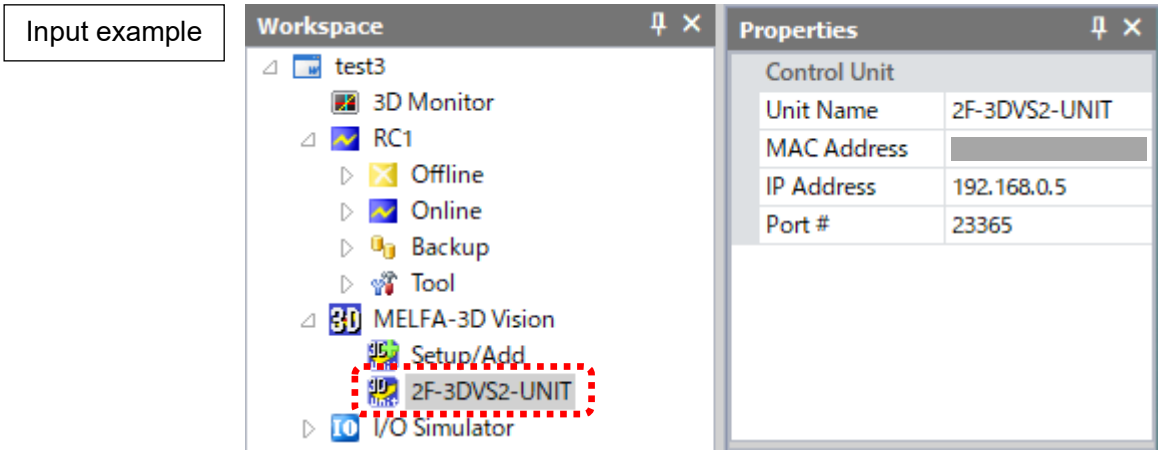


Fig. 6-6 MELFA-3D Vision unit name confirmation screen

(3) When configuring control unit communication settings

To perform the communication settings, select a control unit displayed in the list, and click the [Set Communication] button to display the communication setting screen for the control unit.

The unit name is set to identify the control unit. This unit name also appears in the tree when the control unit is added to the workspace. Change the name as required. Note 1: Note that [2F-3DVS2-UNIT] is set in Unit Name as an initial setting.

Note 1: Up to 32 alphanumeric characters, spaces, and symbols (except for \/:*?"<>|)

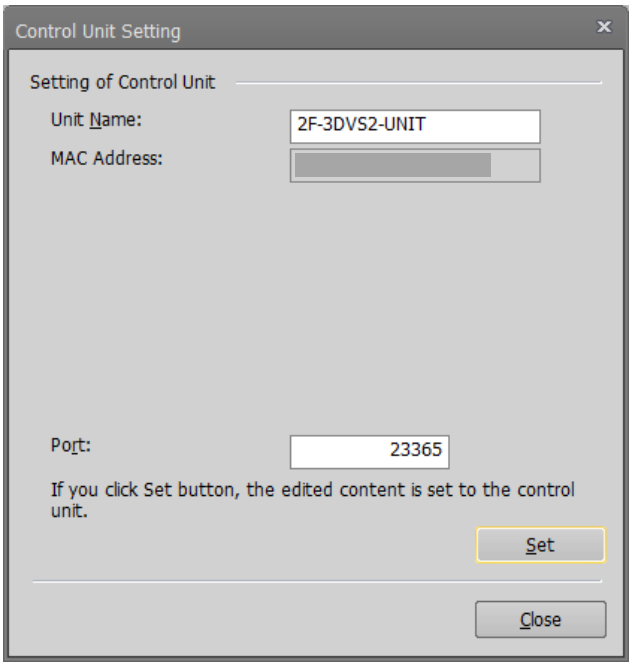


Fig. 6-7 Control unit communication settings window

■ Connection test with the control unit

Select the control unit added to the list on the Setting and Add Control Unit screen and click the [Test Connection] button to perform a connection test with the control unit. When "OK" appears in the Result column, close the Setting and Add Control Unit screen. If the test fails, check the communication settings.

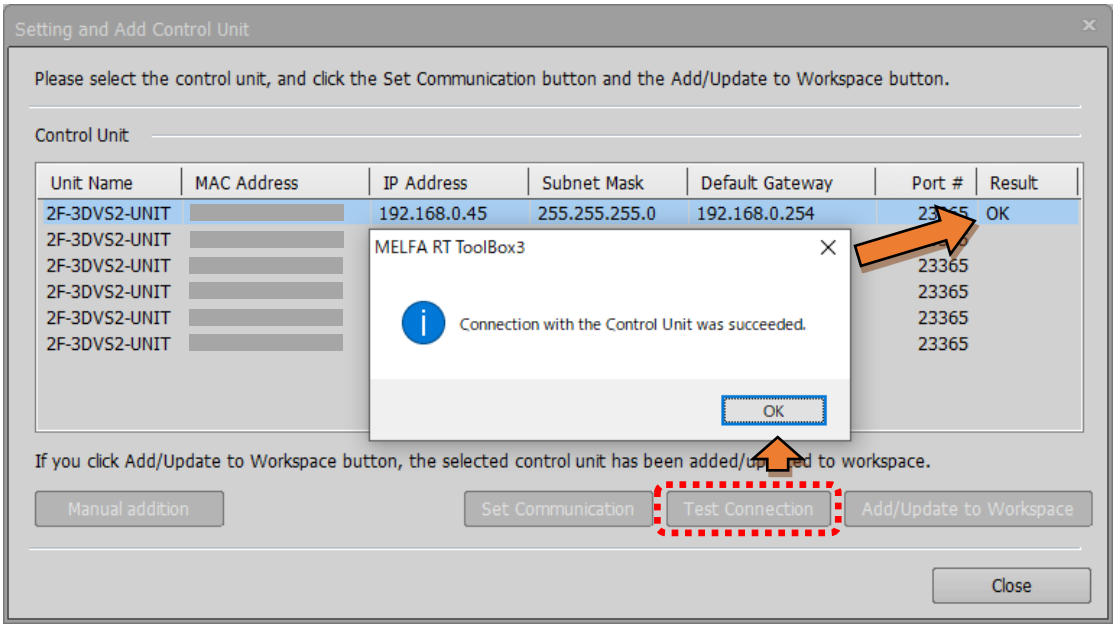


Fig. 6-8 Connection test for the control unit

6.1.2. Robot communication settings

Display the Ethernet parameter screen by clicking [Online] from a project tree - [Parameter] - [Communication parameter] - and double-clicking [Ethernet]. Then, display the list of devices by clicking [Device & Line]. Select the device to be set and click settings. Next, configure the settings as follows.

◇◆◇Robot communication settings◇◆◇

The settings are not required for measurement and recognition checks only (no picking operation).

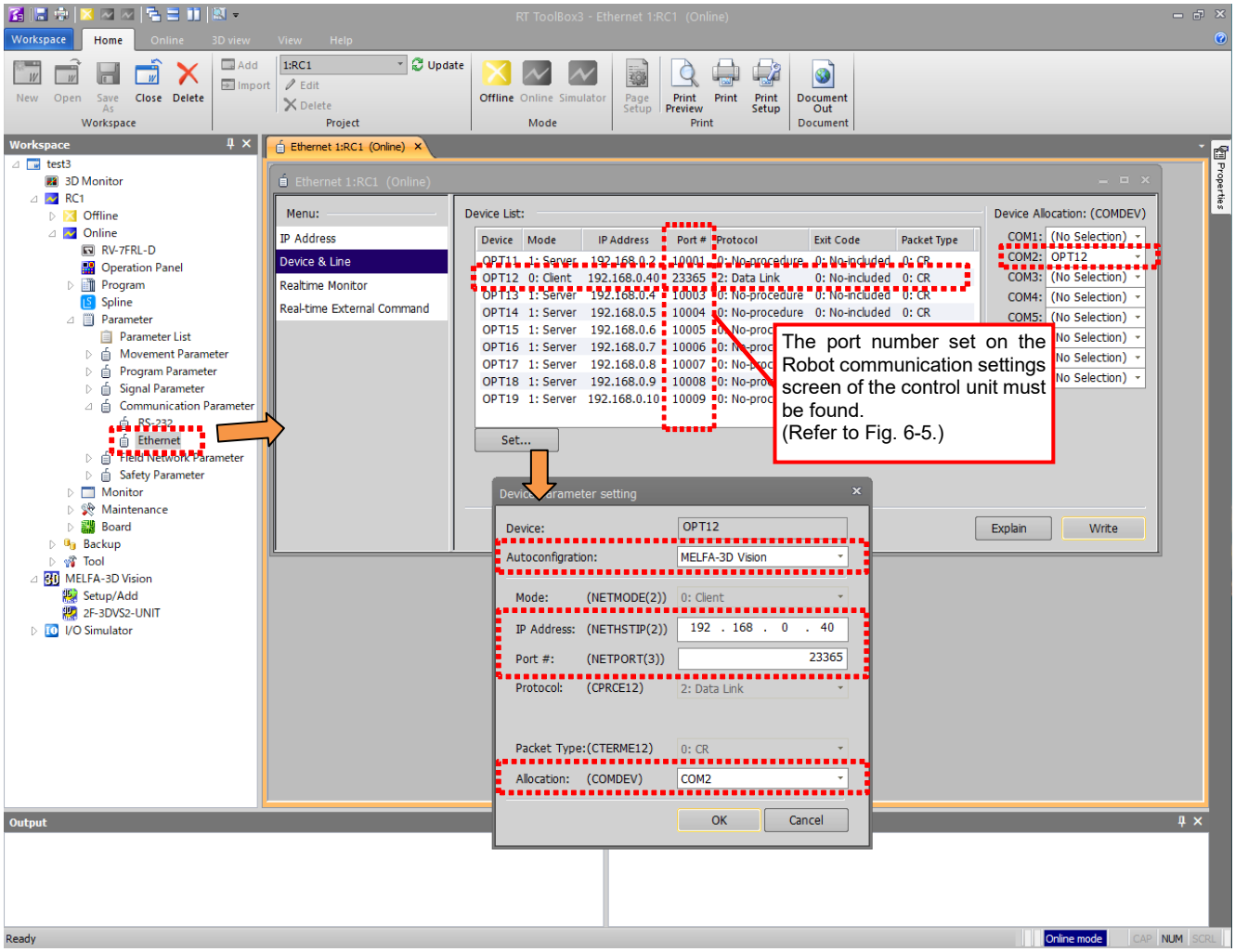


Fig. 6-9 Ethernet setting screen for robots

The sample robot program stored on the supplied USB dongle (3F-53U-WINM) uses "COM2:" for communication with the robot. If using it as is, configure the settings as shown in "Table 6-1".

Table 6-1: Ethernet configuration example for robots

No.	Parameter name	Setting value	Definition
1	Autoconfiguration	MELFA-3D Vision	Select [MELFA-3D Vision] from the selection field.
2	IP address (NETHSTIP(2))	192.168.0.40	Select the IP address for the control unit.
3	Port # (NETPORT(3))	23365	Select the port number for the control unit Note1.
4	Allocation (COMDEV)	COM2	Select the serial port number from the selection field.

Note 1: Use the same port number as the one set in the control unit communication settings.
Click [OK] - [Write] to write to the robot controller and then reboot.

6.2. MELFA-3D Vision settings screen

6.2.1. Accessing the setting screen

Double-click the name of the desired control unit (selectable from the control units added to the RT ToolBox3 workspace). A screen to configure MELFA-3D Vision settings will appear (Fig. 6-10 Instructions for the MELFA-3D Vision setting screen).
The MELFA-3D Vision setting screen is configured as follows.

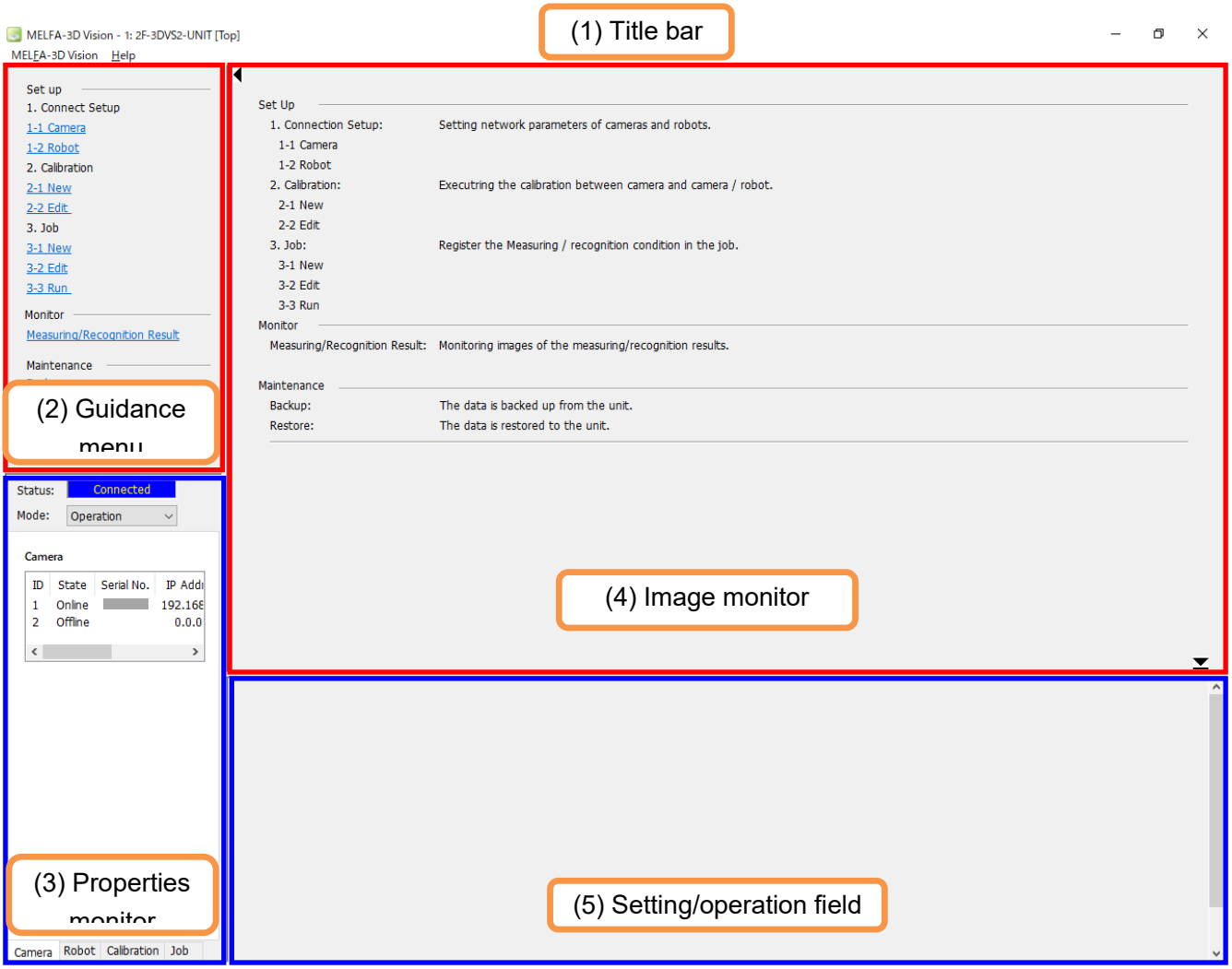


Fig. 6-10 Instructions for the MELFA-3D Vision setting screen

6.2.1.1. Title bar

The title bar displays the following information.

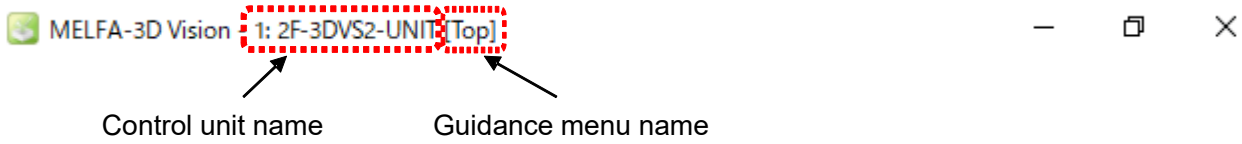


Fig. 6-11 Notation of the title bar for the MELFA-3D Vision setting screen (1)

When creating, editing, or executing calibration data or jobs, the applicable calibration data name or job name is displayed after the guidance menu name.

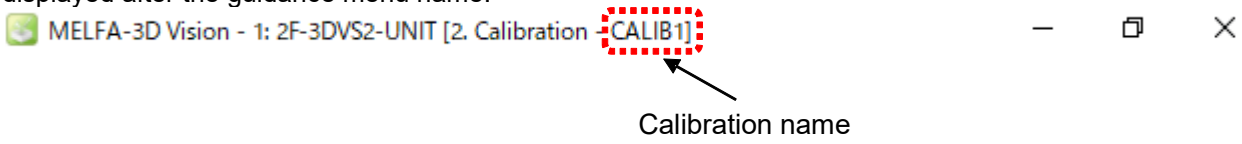


Fig. 6-12 Notation of the title bar for the MELFA-3D Vision setting screen (2)

6.2.1.2. Properties monitor

In the properties monitor, camera connection settings, robot connection settings, calibration data, and job data information are displayed.

For the description of items in the properties monitor, refer to Table 6-2 to Table 6-5.

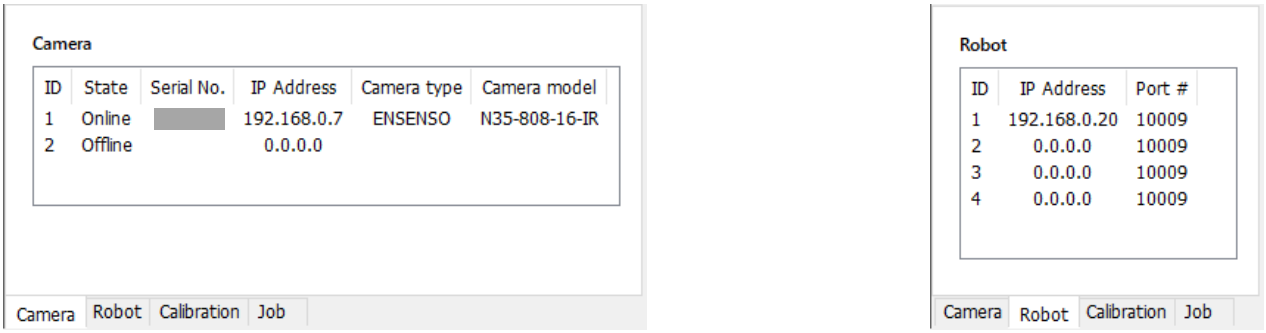


Fig. 6-13 Property monitor (camera, robot)

Table 6-2: Information displayed on the properties monitor (camera)

Item	Description
ID	Camera head ID
State	Camera connection status
Serial No.	Camera serial No.
IP Address	Camera head IP address (Refer to 6.2.2.1 Camera communication settings)
Camera type	Camera manufacturer
Camera model	Camera model name

Table 6-3: Information displayed on the properties monitor (robot)

Item	Description
ID	Robot ID
IP Address	IP address of the connection destination robot (Refer to 6.2.2.2 Settings of communication with the robot)
Port#	Port number of the connection destination robot (Refer to 6.2.2.2 Settings of communication with the robot)

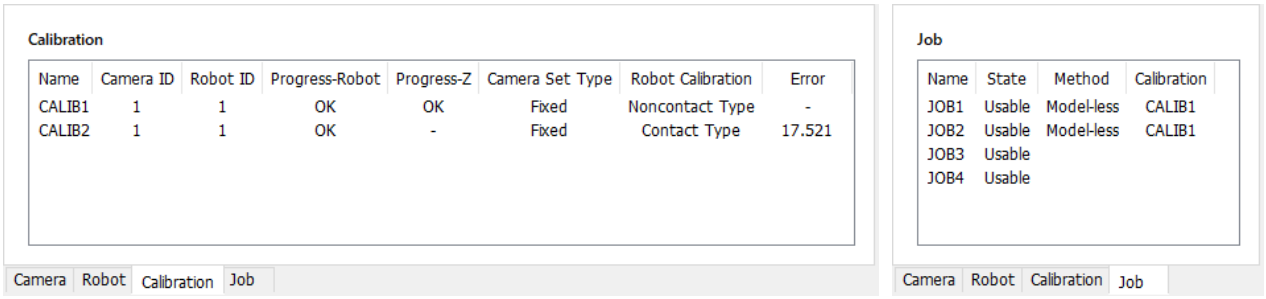


Fig. 6-14 Property monitor (calibration, job)

Table 6-4: Information displayed on the properties monitor (calibration)

Item	Description
Name	Calibration name
Camera ID	Camera ID of the camera head to be used
Robot ID	Robot ID of the robot to be used
Progress-Robot	When completed: OK
Progress-Z	When completed: OK
Camera Set Type	Hand: Hand eye Fixed: Fixed camera
Robot Calibration	Noncontact Type Contact Type (Refer to the items in Table 7-1: Calibration (initial settings))
Error	Shows a robot calibration deviation.

Table 6-5: Information displayed on the properties monitor (job)

Item	Description
Name	Job name
State	Enabled/Disabled
Method	Model-less/Model-matching
Calibration	Name of the calibration to be used

The properties monitor can also be used to check the status of the connection with the control unit, and to change the operation mode from a drop-down menu.

Fig. 6-15 Control unit connection status

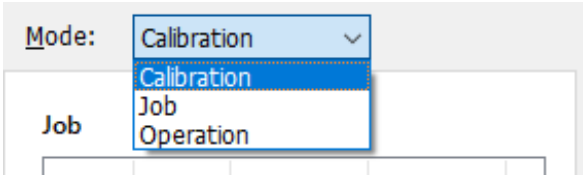


Fig. 6-16 Operation mode change

◇◆◇Operation modes◇◆◇

Operations modes are described in the following table.

Operation mode	Description
Calibration	No requests other than calibration commands from the robot controller are accepted.
Job	No requests are accepted from the robot controller.
Operation	All requests other than calibration commands from the robot controller are accepted.

■ Camera tab
From the context menu that appears by right-clicking the Camera tab, live images can be displayed. Images captured by the camera (left side) are used for live images (Refer to "2.4.2 Name of each part".).

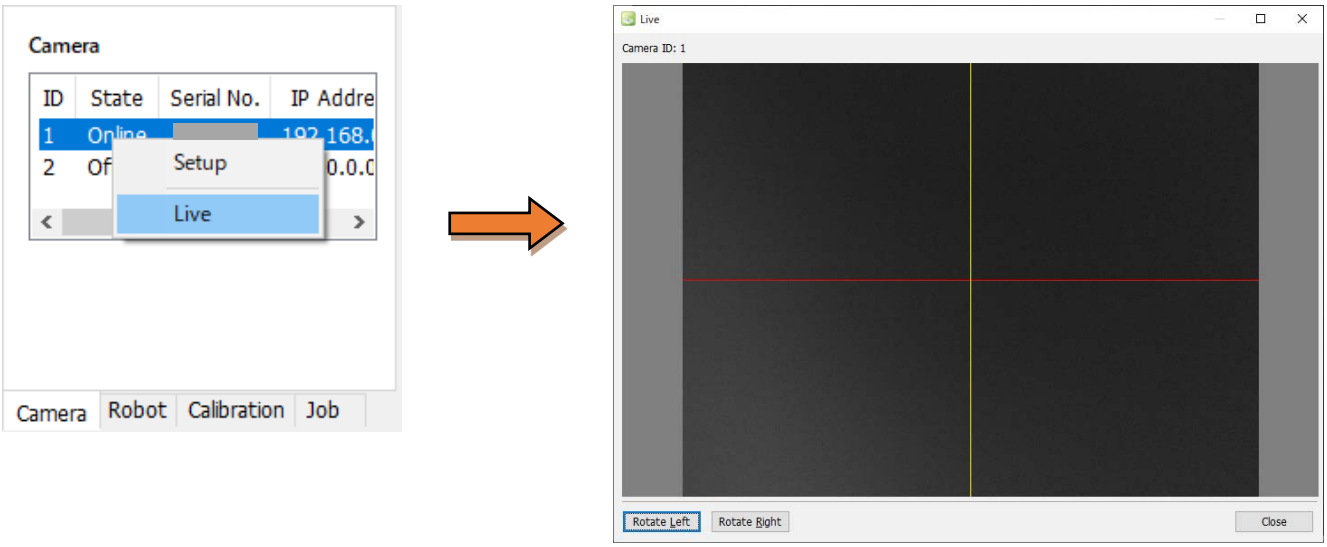


Fig. 6-17 Live image

6.2.1.3. Image monitor

The image monitor is used to display live images, measurement results, recognition results, and other information. (For information on measurements, refer to 8.2. For information on recognition, refer to 8.3.)

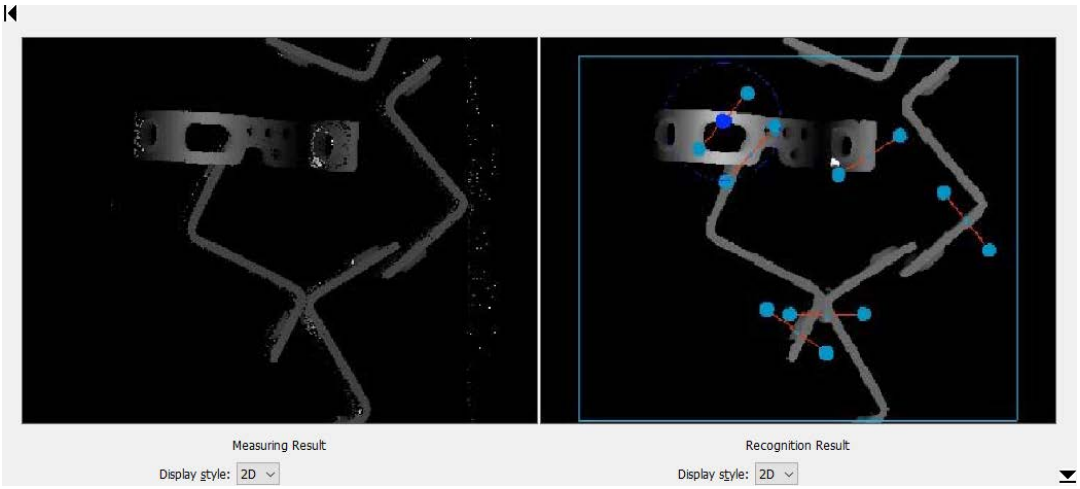


Fig. 6-18 Image monitor

The image center on 2D images displayed at the monitor is the XY origin of the camera coordinate system (Refer to 2.4.4).

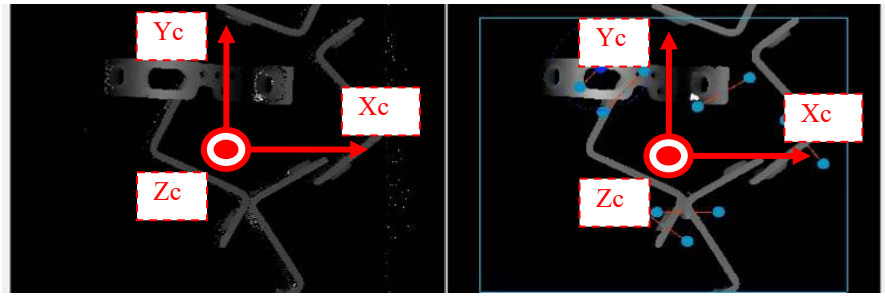


Fig. 6-19 Camera coordinate system in image monitor

By selecting "3D" for the display format, measurement and recognition results can be displayed in 3D. The viewpoint can be changed using the mouse (see Table 6-6).

Table 6-6: Mouse operation to change image monitor (3D display) viewpoint

Viewpoint change	Mouse operation at graphic display
Viewpoint rotation	While left-clicking, move left and right to rotate around the Z-axis. Move up and down to rotate around the X-axis. While clicking the left and right buttons, move left and right to rotate around the Y-axis.
Viewpoint movement	While right-clicking, move up, down, left, and right.
Enlarging/reducing graphic images	While holding down the [SHIFT] key and left-clicking, move up and down.

Furthermore, by selecting the texture display check box, 2D images captured by the camera are mapped and displayed over 3D data.

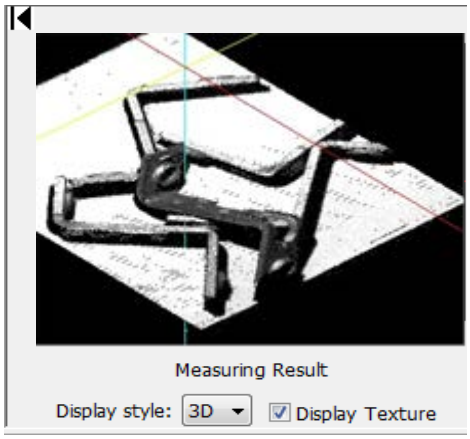


Fig. 6-20 Image monitor (3D display)

6.2.1.4. Setting/operation field

A Setting/operation screen according to the operation is displayed in the setting/operation field.

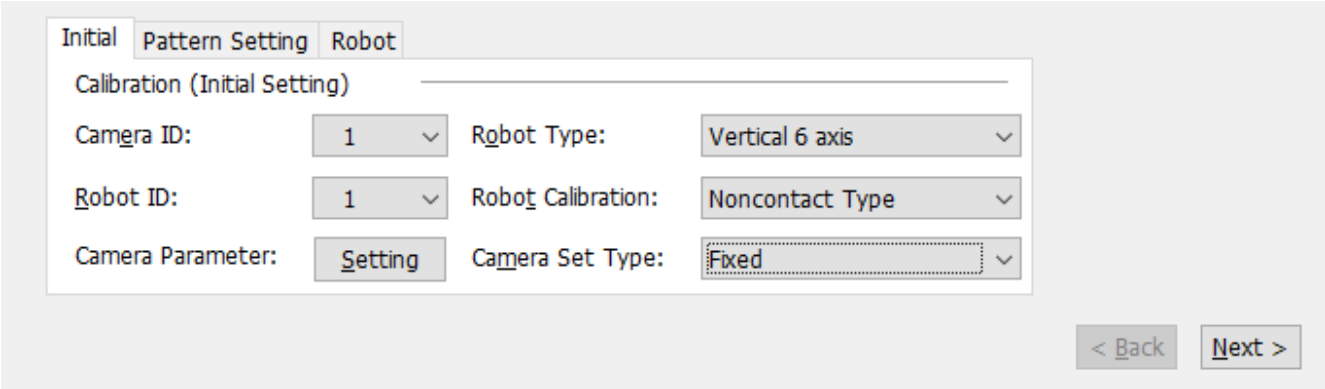


Fig. 6-21 Calibration setting/operation field

6.2.2. Control unit communication settings

6.2.2.1. Camera communication settings

■ Camera settings screen display

By clicking [Startup] - [1. Connection Setup] - [1-1 Camera setting] in the guidance menu in the MELFA-3D Vision setting screen, a Camera settings screen appears

.

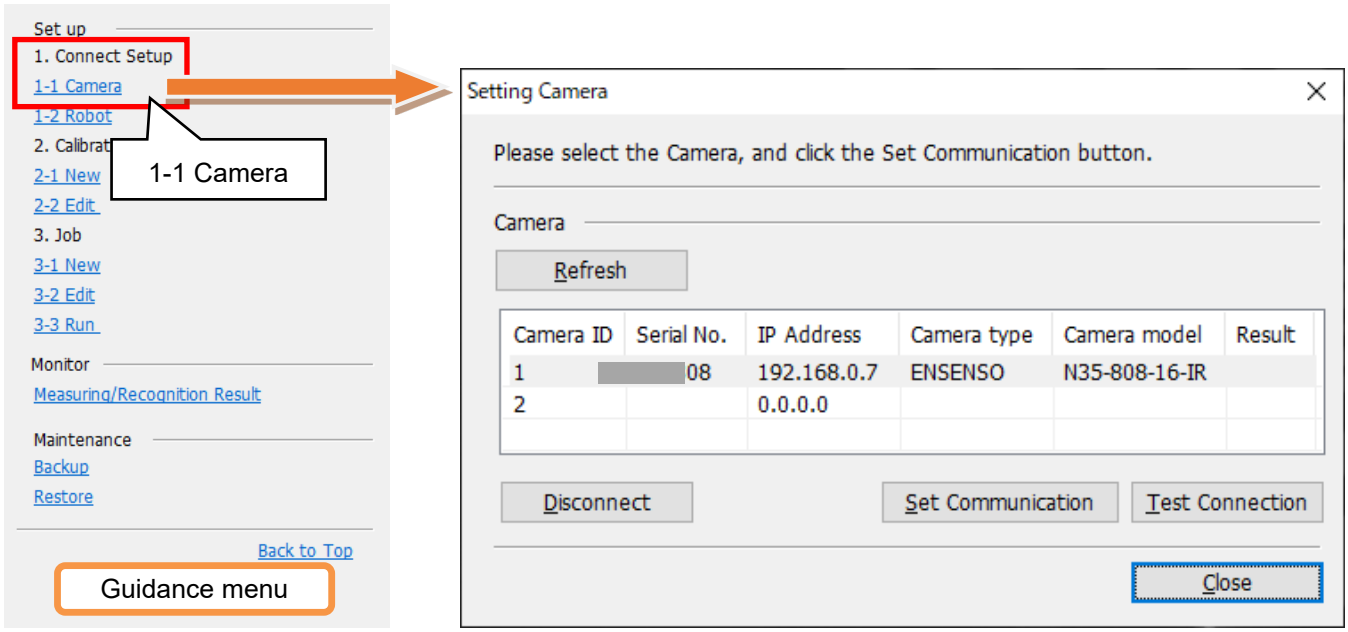


Fig. 6-22 Camera settings

■ Camera communication settings

Up to two cameras can be connected to one control unit. The two cameras are identified by their camera ID. By selecting the camera ID for the camera to be registered and then clicking the [Set Communication] button, the Camera communication settings screen appears. Select the camera head's serial number from the Serial No drop-down box. Please note that the serial numbers of all camera heads on the same network appear in the Serial No drop-down box. Enter the IP address of the camera so that the address is not duplicated with other devices on the network to which the control unit is connected Note 1. Clicking the [Set] button will write camera communication settings to the control unit.

Note 1: When "0,0,0,0" is set in the IP Address field, communication with the camera is disconnected.

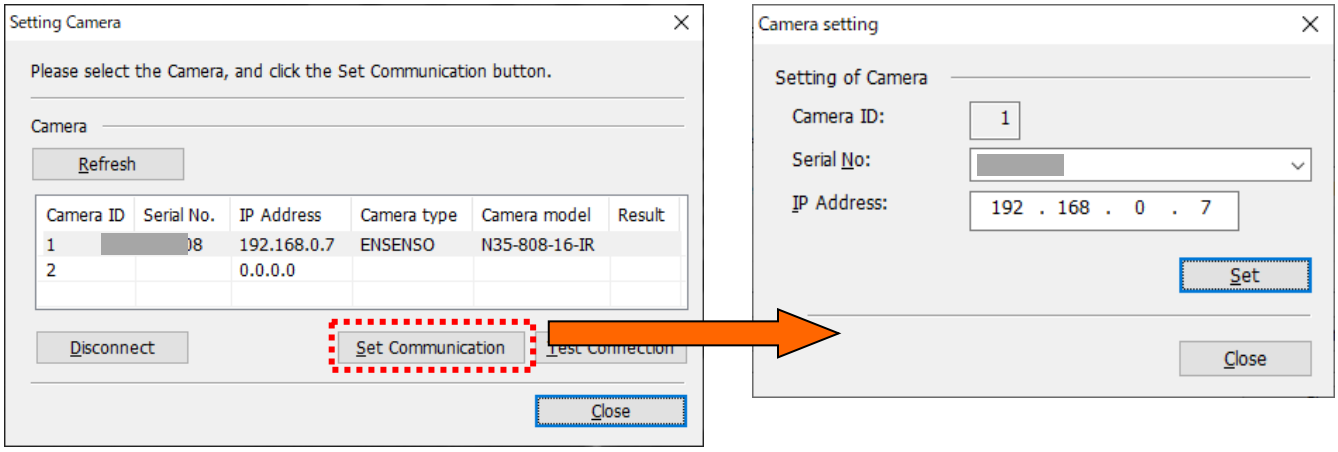


Fig. 6-23 Camera communication settings

■ Connection test

By selecting the camera for which communication settings were specified and then clicking the [Test Connection] button, a connection test is performed for the selected camera. If the connection test result is OK, close the Camera settings screen. If the test fails, check the camera communication settings.

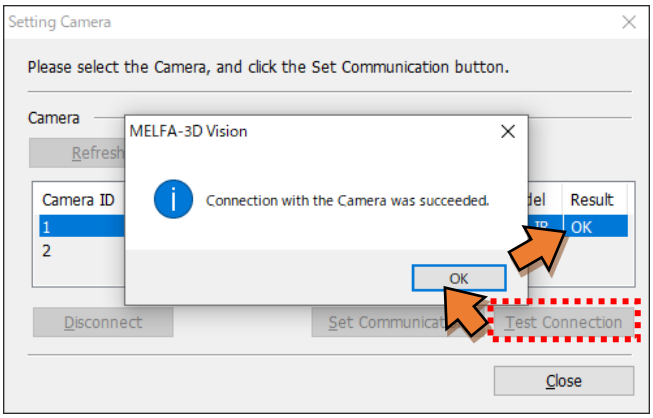


Fig. 6-24 Camera connection test

■ Circuit disconnection

If disconnecting the circuit for cameras for which communication settings are completed, select the camera from the list, and then click the [Disconnect circuit] button.

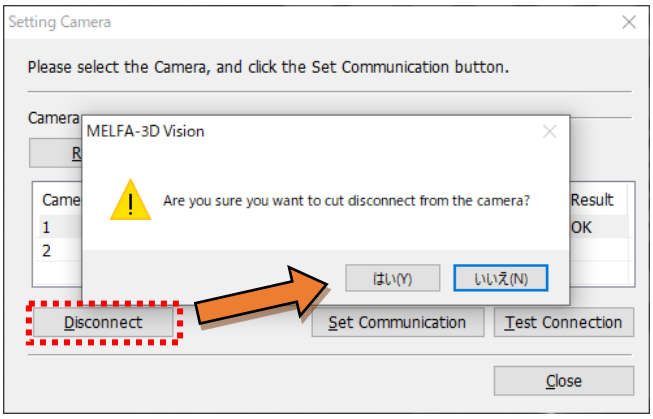


Fig. 6-25 Camera circuit disconnection

◇◆◇ Communication interruption ◇◆◇

Communication with the camera may remain interrupted in situations such as the following:
Communication with the camera is interrupted, and the control unit enters sleep mode. If this is the case, configure the settings again or restart the MELFA-3D Vision application.

6.2.2.2. Settings of communication with the robot

■ Robot setting screen display

This screen is used to specify robot communication settings. By clicking [1. Connection Setup] → [1-2 Robot] in the guidance menu of the MELFA-3D Vision setting screen, a Setting Robot screen appears.

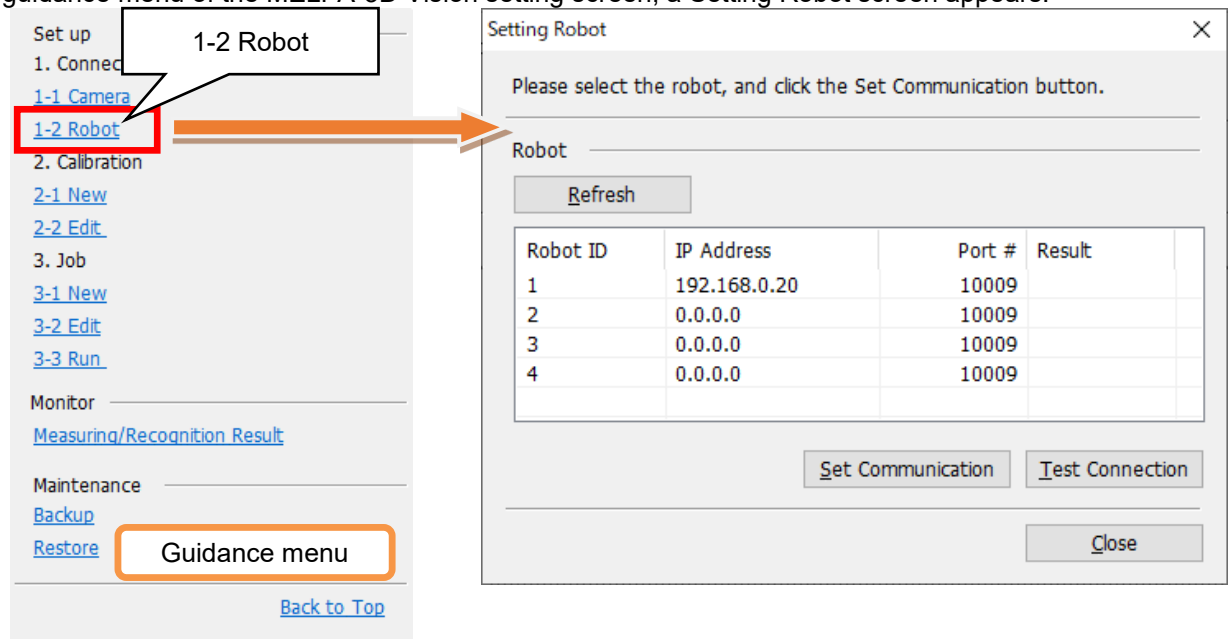


Fig. 6-26 Robot settings

■ Robot communication settings

Up to four robots can be connected to one control unit. The four robots are identified by their robot ID. By selecting the robot ID for the robot to be registered and then clicking the [Set Communication] button, a Robot communication settings screen appears. Enter the IP address set for the robot in the IP address field. Enter the port No. to be used in the Port No. field Note 1. Clicking the [Set] button will write robot communication settings to the control unit.

◇◆◇Port Nos.◇◆◇

Select the port No. to be set from 10001 to 10009. When doing so, ensure that the selected port is not used in the Ethernet settings in the robot parameters.

Note 1: The port No. used must be set in one of the robot parameter NETPORT elements, and not be used for communication for any other devices. (See Fig. 6-9)

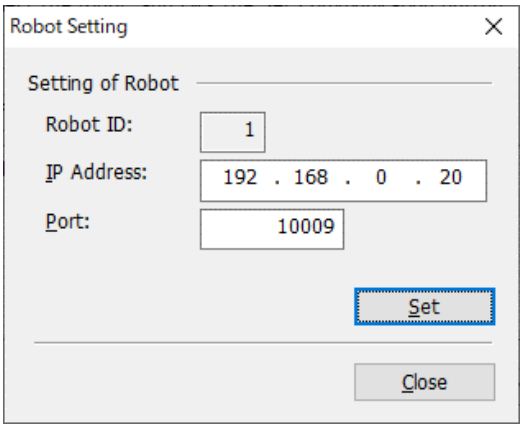


Fig. 6-27 Robot communication settings

■ Connection test
By selecting the robot for which communication settings were specified and then clicking the [Test Connection] button, a connection test is performed for the robot. If the connection test result is OK, close the Robot settings screen. If the test fails, check the robot communication settings.

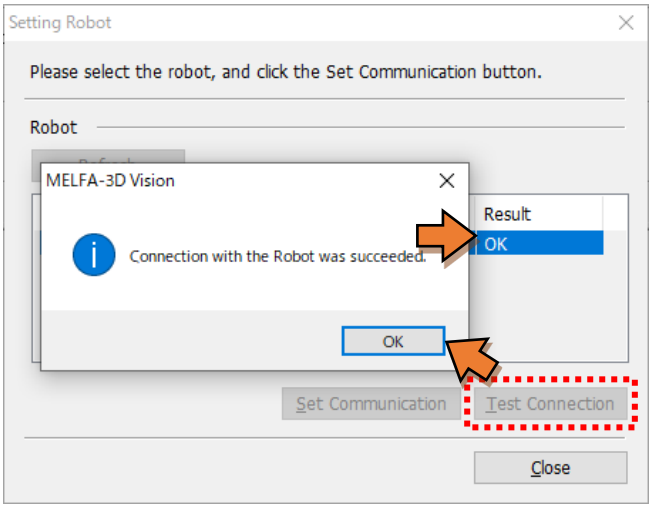


Fig. 6-28 Robot connection test

7. Calibration

■ Creating new calibration data
Perform calibration of the camera.
Click [2. Calibration] → [2-1 New] from the guidance menu on the MELFA-3D Vision setting screen. New calibration data will be created and the calibration setting screen will appear.

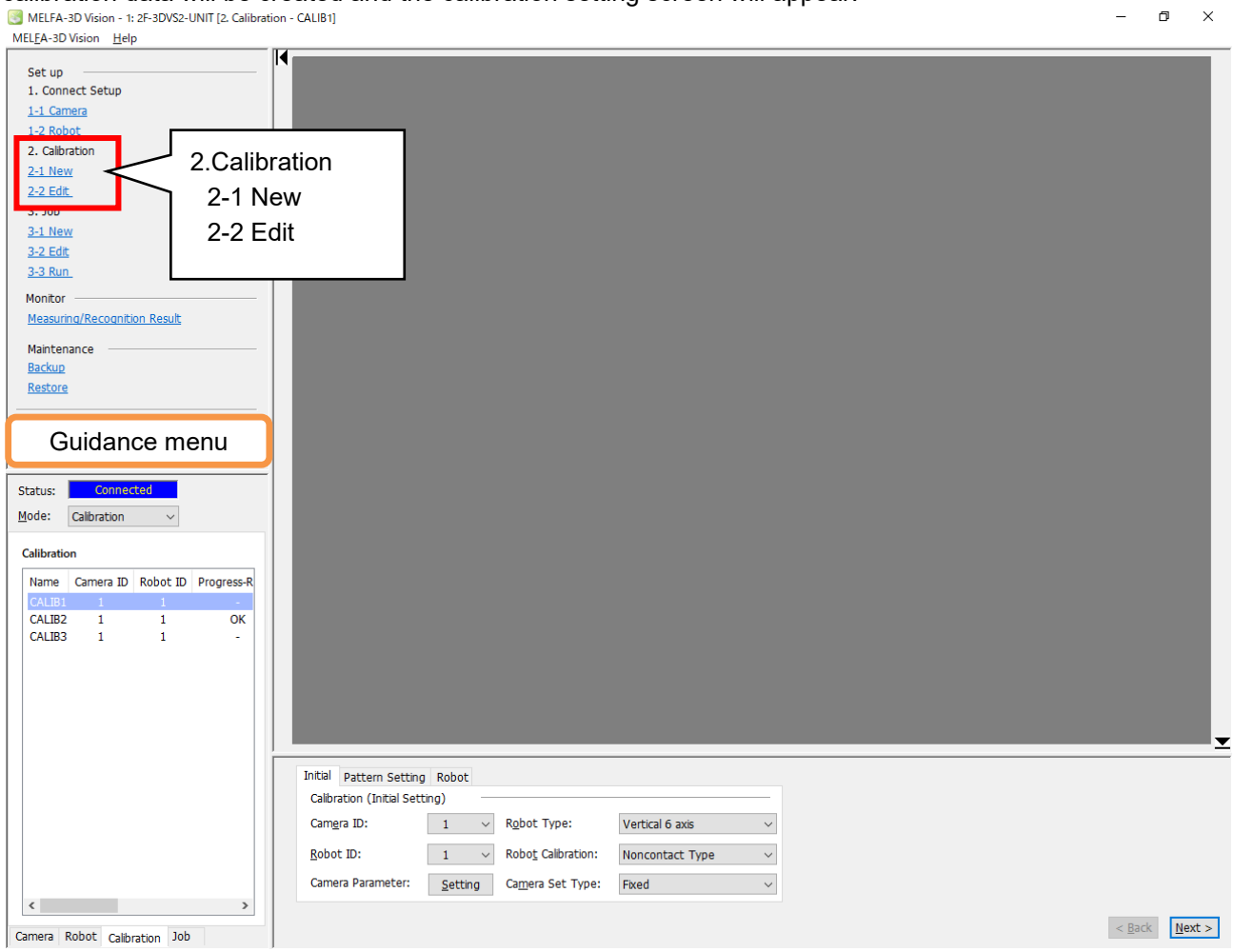


Fig. 7-1 Calibration setting screen

◇◆◇Creating new calibration data◇◆◇
New calibration data can also be created from the context menu that appears when right-clicking the "Calibration" tab in the Properties window.

7.1. Initial settings

In the initial settings, select the following items according to the equipment configuration. When selection is completed, click the [Next] button.

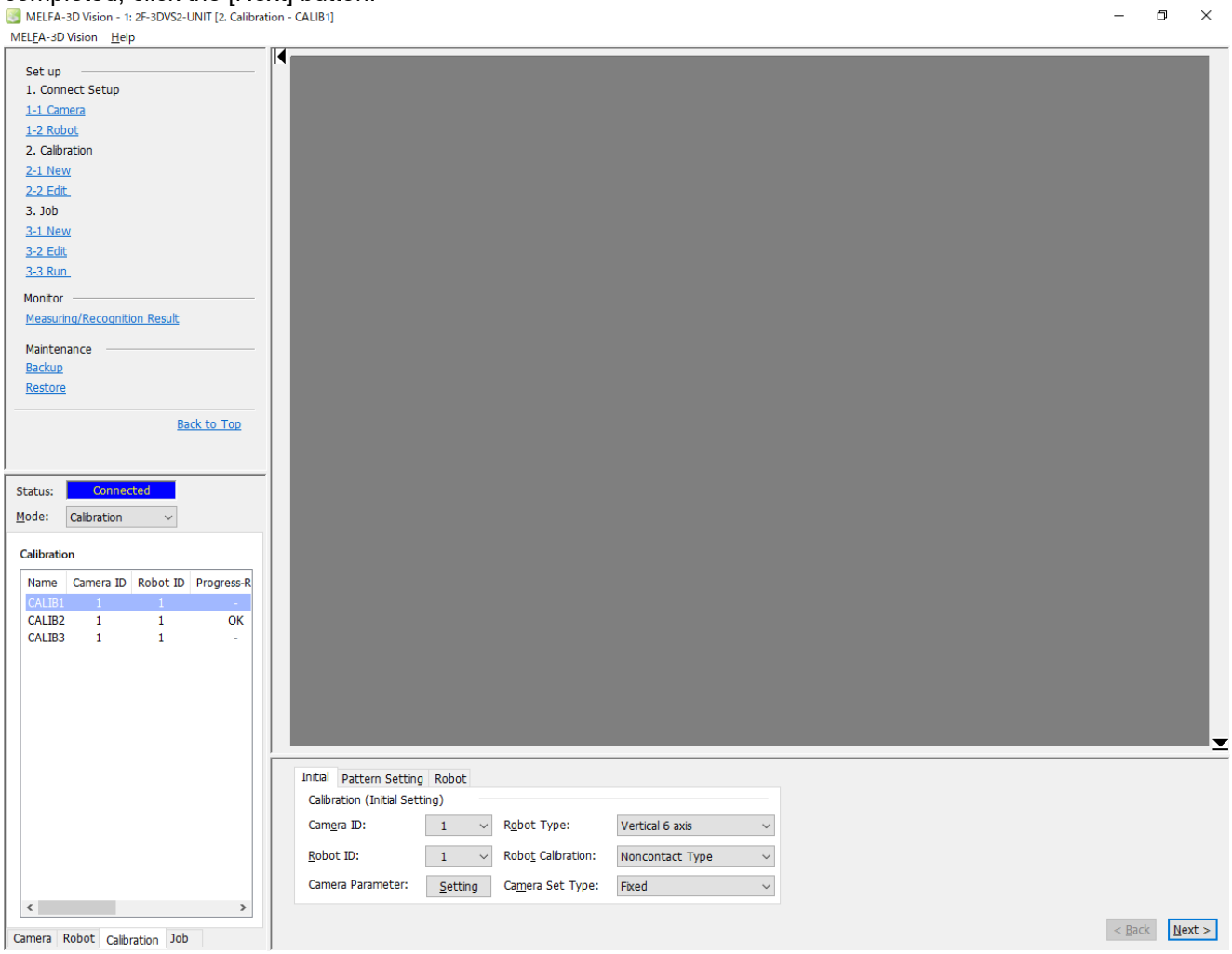


Fig. 7-2 Calibration (initial settings)

Table 7-1: Calibration (initial settings)

Item	Description
Camera ID	Camera ID being used
Robot ID	Robot ID being used
Robot type	Vertical 6-axis robot or other robots
Robot Calibration	Non-contact type or contact type (Refer to "Table 7-3: Robot calibration type".)
Camera Set Type	Hand eye / Fixed camera
Camera parameter	Refer to "Camera parameters" stated below.

■ Camera parameters

The Camera parameter setting window can be accessed from the [Set] button in the Camera parameter list window. By changing a value and clicking the [Set] button, the Camera parameter settings screen closes and returns to the Camera parameter list screen. At this point, the parameter has not yet been set in the control unit. By clicking the [Set] button in the Camera parameter list screen, the changed parameter value is set in the control unit.

To enable automatic adjustment for the value of "ExposureTime", set "AutoExposureTime" to "1". To enable automatic adjustment for the value of "Gain", set "AutoGain" to "1".

◇◆◇Measurement results◇◆◇

If the result of workpiece measurement described in "8 Measurement and Recognition Settings" is not satisfactory, measurement results may improve by changing the camera parameters.

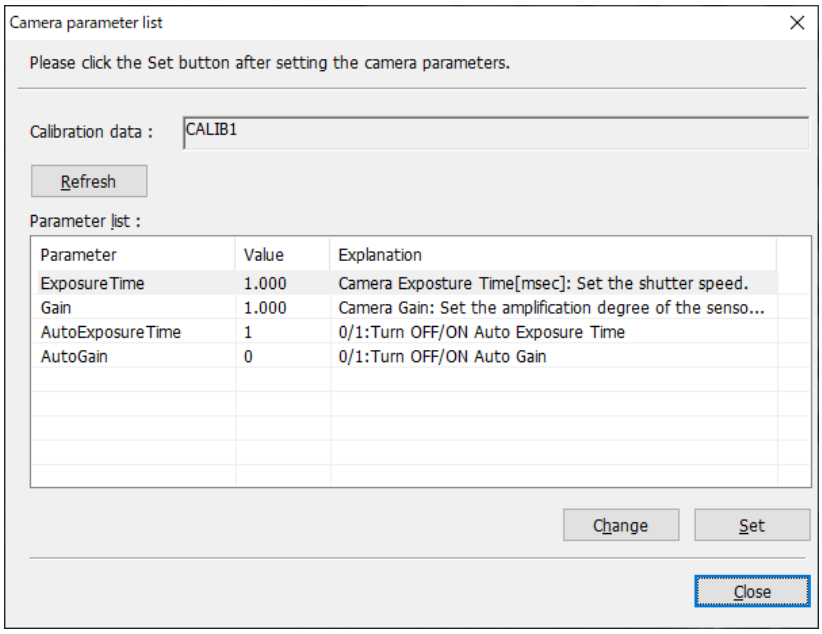


Fig. 7-3 Camera parameter list

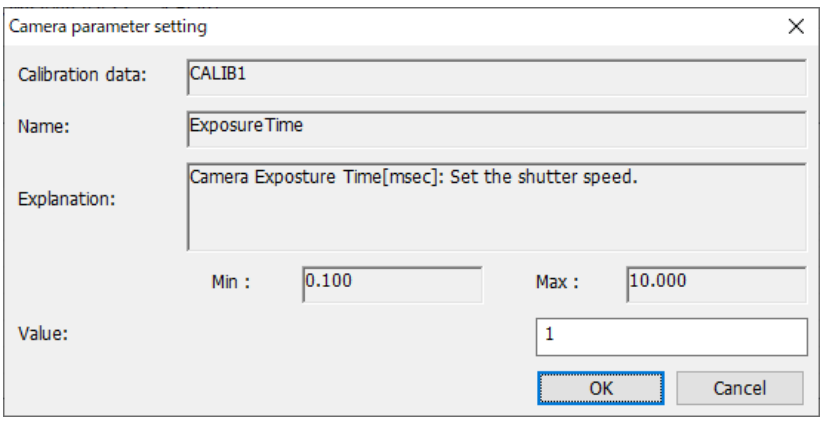


Fig. 7-4 Camera parameter settings

Table 7-2: Camera parameter list

Parameter name	Unit	Description	Range
ExposureTime	msec	Camera exposure time [msec]: Set the shutter speed.	0.100 to 10.000
Gain Note 1	-	Camera gain: Set the amplification degree of the sensor signal (Sensitivity).	1.0 to 9.9
AutoExposureTime	-	0/1: Turns off or on automatic exposure adjustment.	0,1
AutoGain	-	0/1: Turns off or on automatic gain adjustment.	0,1

Note 1: Even if a value larger than 4.0 is set for the N35 series, the value will be treated as 4.0.

◇◆◇Exposure time◇◆◇
If the measurement test is not satisfactory for black or dark objects, it may be possible to improve the result by increasing the exposure time.

◇◆◇ Camera gain ◇◆◇
When a larger gain value is input, the image becomes brighter, which increases the noise in proportion to the value.

7.2. Robot calibration

Robot calibration is an operation to calculate the positional relationship between the camera and the robot. The operation differs depending on the camera attachment type (hand eye or fixed camera) or the robot type.

7.2.1. Calibration types

There are two types of calibration as shown below.
■ Non-contact
Vertical 6-axis robots: Automatic robot operation (mark recognition in different postures)
Others (horizontal 4-axis and vertical 5-axis robots): One-point teaching and automatic operation (mark recognition in different postures)
■ Contact
This type is available for fixed cameras only, but available for any types of robots.

Calibration type can be selected according to the robot type and camera attachment type as shown in the table below. For information on required items, refer to the chapter related to the type being used.

Table 7-3: Robot calibration type

Robot type	Camera attachment type	Calibration type	Characteristics and restrictions	Items supplied by customer
Vertical 6-axis robot	Fixed camera	Non-contact type (recommended)	[Outline] The robot grasps the calibration plate/pattern and images are captured while the robot is changing the plate posture. [Advantages] • Calibration accuracy is not affected by teaching accuracy. • Automatic operation by clicking a button. [Precautions] Sufficient working space is required to prevent the robot from interfering with surrounding objects.	• Calibration plate/pattern • Plate grasping jig • Camera installation jig
		Contact type	[Outline] The robot is taught five points on the calibration sheet placed on the workbench by pointing at them with a tapered jig. [Advantages]	• Tapered jig

			Operation possible even in narrow working space. [Precautions] • Manual operation • Tool calculation of the tapered jig is required. • Teaching accuracy directly affects calibration accuracy.	
	Hand eye	Non-contact type (recommended)	[Outline] Images of the calibration plate/pattern placed on the workbench are captured while the robot is changing the posture. [Advantages] • Calibration accuracy is not affected by teaching accuracy. • Automatic operation by clicking a button. [Precautions] Sufficient working space is required to prevent the robot from interfering with surrounding objects.	• Calibration plate/pattern • Camera installation jig
Others (horizontal 4-axis and vertical 5-axis robots)	Fixed camera	Non-contact type	[Outline] Images of the calibration plate/pattern placed on the workbench are captured while the robot is changing the posture, then the robot is taught one point in the Z coordinate. [Advantages] • Calibration accuracy is not affected by teaching accuracy (except the Z component). • Automatic operation by clicking a button (except one point, which is operated manually). [Precautions] • Sufficient working space is required to prevent the robot from interfering with surrounding objects. • Teaching accuracy directly affects calibration accuracy (Z component).	• Calibration plate/pattern • Plate grasping jig • Camera installation jig
		Contact type	[Outline] The robot is taught five points on the calibration sheet placed on the workbench by pointing at them with a tapered jig. [Advantages] Operation possible even in narrow working space [Precautions] • Manual operation • Tool calculation of the tapered jig is required. • Teaching accuracy directly affects calibration accuracy.	• Tapered jig
	Hand eye	Non-contact type	[Outline] Images of the calibration plate/pattern placed on the workbench are captured while the robot is changing the posture, then the robot is taught one point in the Z coordinate. [Advantages] • Calibration accuracy is not affected by teaching accuracy (except the Z component). [Precautions]	• Calibration plate/pattern

			• Sufficient working space is required to prevent the robot from interfering with surrounding objects. • Teaching accuracy directly affects calibration accuracy (Z component).	

7.2.2. Calibration plates/pattern

■ Markers used for non-contact type
This type requires the calibration plates/pattern stated below.

The relationship between the camera and robot coordinates is found from the marker images captured while the robot is changing the marker posture.

The following website allows you to find which calibration plate/pattern is best suitable for the N35 / N36 series camera being used. Select the camera on the website.
https://en.ids-imaging.com/store/ensenso-accessories

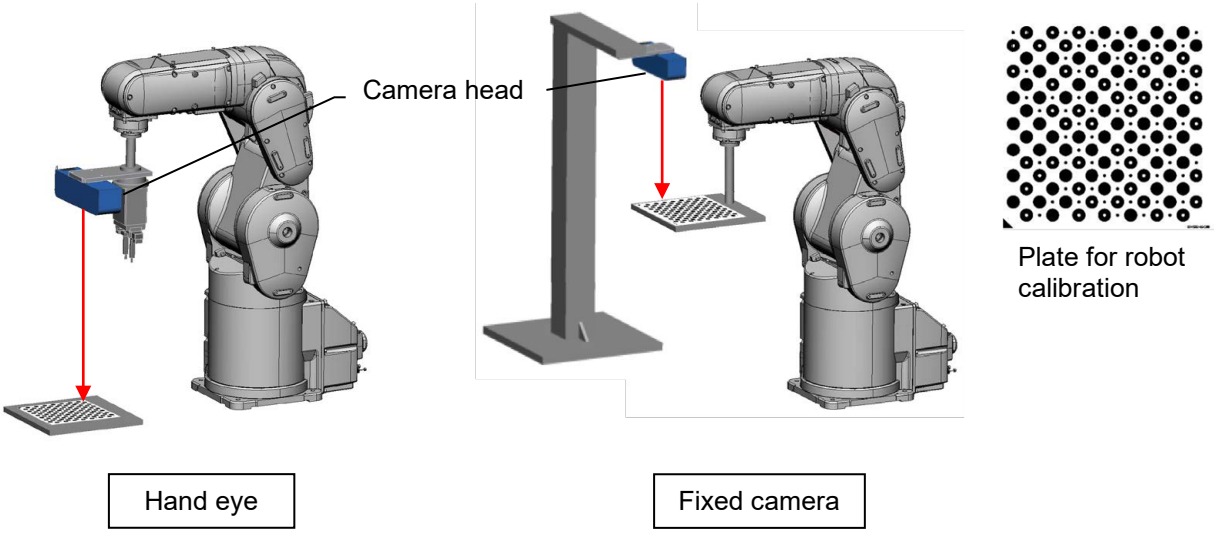
The calibration plate/pattern must occupy at least 1/2 of the field of view. Select and use a marker according to the field of view (For details, refer to "3.2 Items to be Prepared by Customer ".).

■ Markers used for contact type

This type requires a calibration sheet such as the one in "15.3 Calibration Sheet (For Contact type calibration)". After five marks have been recognized at one time, the relationship between the camera and robot coordinates is found by pointing at the center of the marks with the robot.

Therefore, attach a tapered object to the robot hand so that mark pointing is possible, and configure tool settings beforehand. If the hand has a tapered top, such an object is not required. If not, attach an object for position pointing.

Non-contact



Contact type

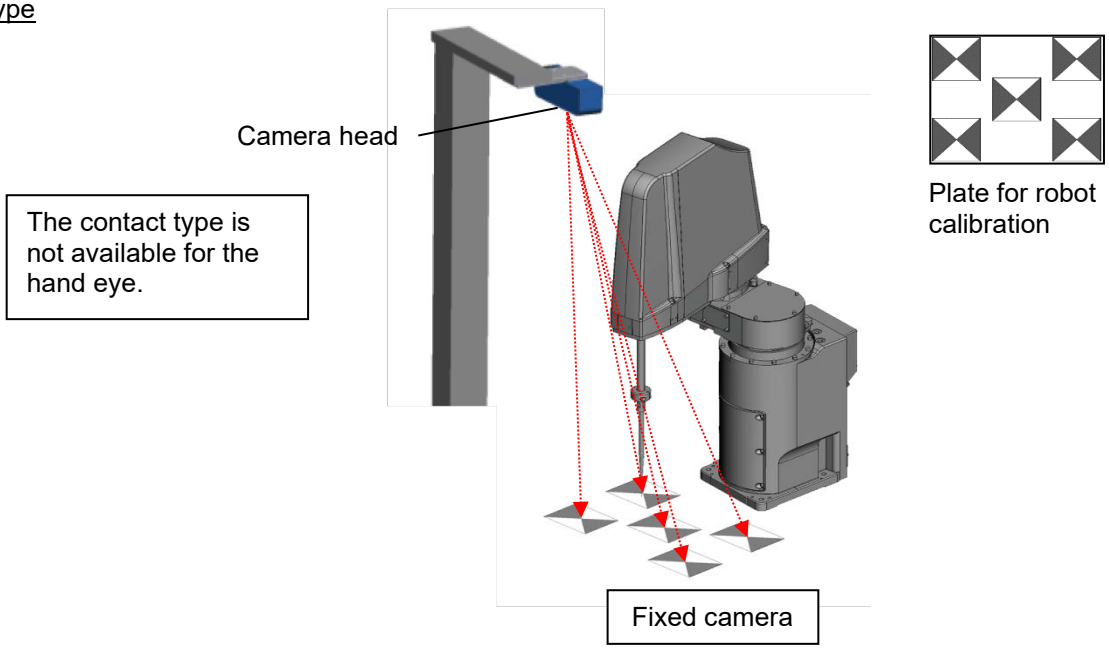


Fig. 7-5 Hand eye and fixed camera

7.2.3. Non-contact type (before calibration)

The positional relationship between the camera and the robot is found by capturing images of the marker in different postures.

■ Entering calibration pattern information.

In the setting/operation field, click the "Pattern Setting" tab and enter the following values under "Calibration pattern setting" (shown in Fig.7-7).

Table 7-4: Pattern settings

Setting	Description
Pattern points	The number of dots on one side of the robot calibration plate/pattern
Grid size [mm]	Distance between dots on the robot calibration plate/pattern

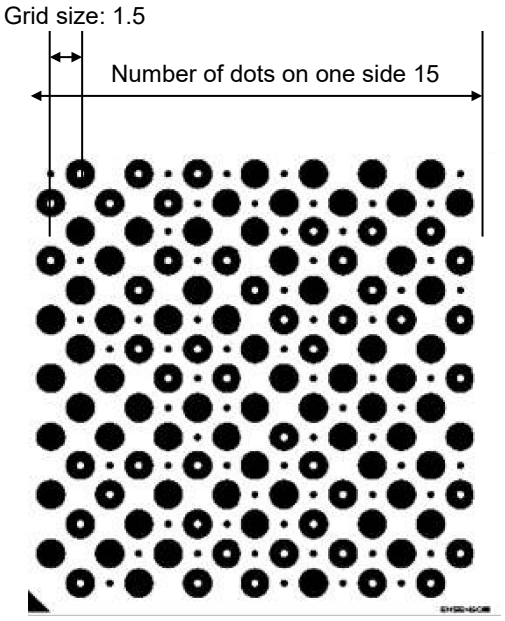


Fig.7-6 Calibration pattern example

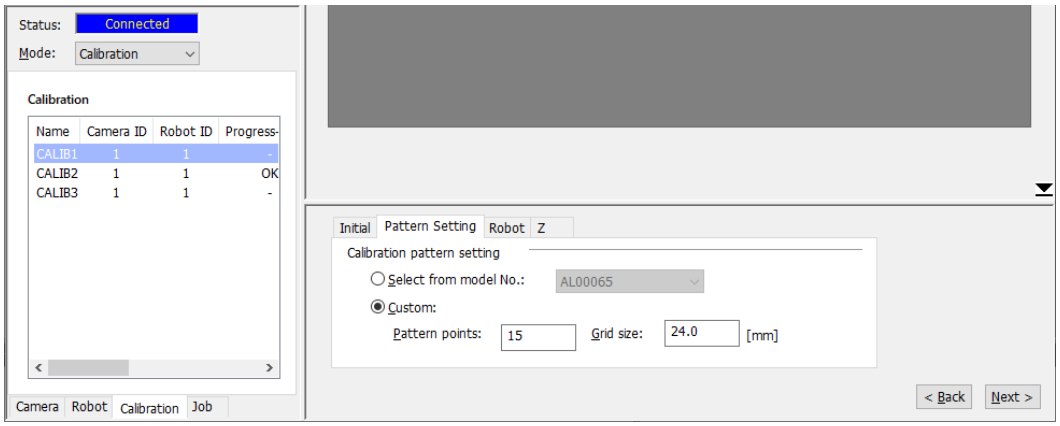
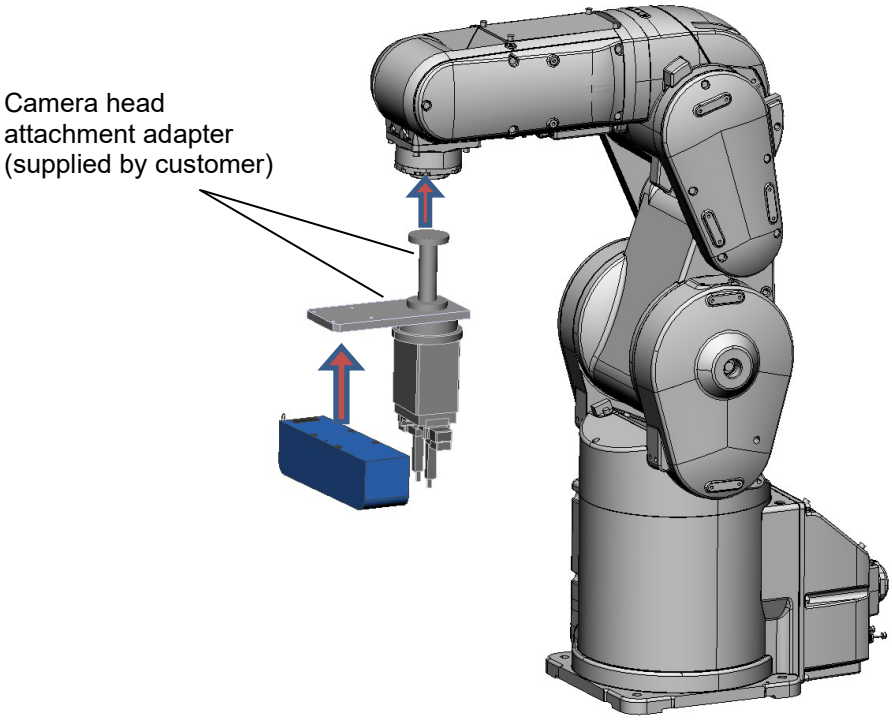


Fig.7-7 Calibration pattern settings

7.2.4. Non-contact type (hand eye)

The positional relationship between the camera and the robot is found by capturing images of the marker placed on the floor while the robot is changing the camera posture.
A jig to attach the camera is required.
Example: Facing the flange and camera vertically downward and placing a marker on the floor



■ Moving the robot to the initial position

Operate the robot to move it to a place where it can make big movements without interfering with surrounding objects. While checking the live images displayed on the screen, position the marker so that it is seen near the center of the camera angle of view. Note 1

Note1: Images captured by the camera (left side) are used for live images (Refer to "2.4.2 Name of each part").

Ensure that the distance between the marker and camera head is about the same as the intended working distance in the actual operation Note 1.
Note 1: By doing so, the depth of focus (condition of focus) will be equal between calibration and actual operation.

Make sure that the optical axis of the camera and the marker are vertical to each other. When the following conditions are satisfied, they can easily become vertical by hand alignment.
• The robot installation surface is parallel to the XY plane in the camera coordinate system.
• The marker is parallel to any of the XY plane, YZ plane, or ZX plane in the robot tool coordinate system.

◇◆◇ Base and tool settings ◇◆◇
Changing the base or tool settings from the default values will not affect robot calibration. Note 1

Note 1: The marker must be seen under the following conditions.
• The current tool coordinates are set so that the XY plane of the tool coordinates and the XY plane of the camera coordinates are parallel.
• Each side of the marker is approximately parallel (within 5 degrees) to its corresponding side of the angle of view.
(Fig.7-9 Live image with the robot in its initial position (example))
• The center of the marker is seen near the center in the 1/2 area of the angle of view.

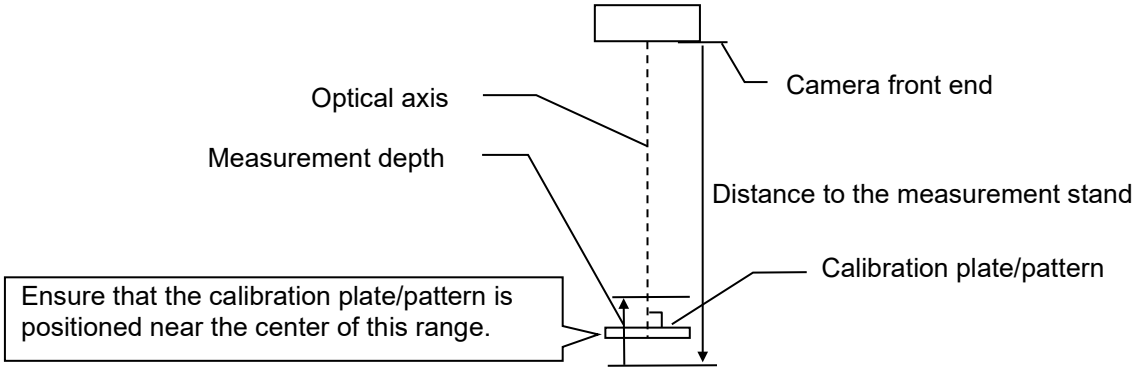


Fig.7-8 Distance to the calibration plate/pattern

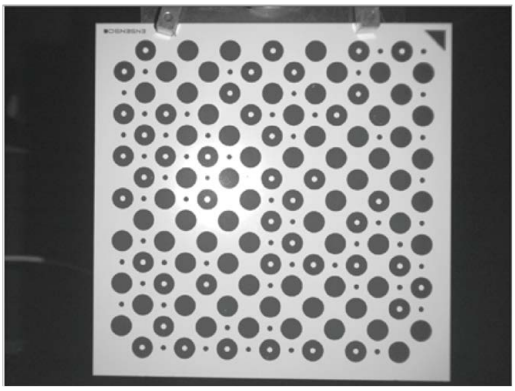


Fig.7-9 Live image with the robot in its initial position (example)

■ Executing the calibration program
RT ToolBox3 and the robot controller need to be connected online.
In the setting/operation field, click the "Robot" tab to display the Robot-Calibration (Noncontact Type) window. Then, perform the steps in "Fig.7-6 Calibration pattern example" to execute the program. Before starting automatic operation, make sure that there are no obstacles in the surroundings. Be aware of the override speed. If communication cannot be established properly among the camera, robot, and control unit, automatic operation may stop.
The time it takes to run the calibration program depends on the field of view size (mm × mm) and calibration plate/pattern area relative to the angle of view. As the area ratio is higher, the running time becomes shorter.
[Approximate running time]
In the following conditions, it takes approximately 15 minutes when O/P OVRD is set to 10%, and approximately 8 minutes when O/P OVRD is set to 30%.
Camera: N35-802-16-IR
Robot: RV-5AS
Calibration plate/pattern: AL00091
Plate area relative to the angle of view: approximately 1/2

■ Robot operating range
During calibration, the robot will move the following amount at maximum. Be aware of the length of the camera installation jig and prevent interference with surrounding objects.
Do not set the initial position to a position where the structure flag switches halfway through. If the robot moves to a structure flag switching point during robot calibration, the robot may make a big movement.
For details on structure flags, refer to the instruction manual "Detailed explanations of functions and operations".

Table 7-5: Robot operating range

Operation direction (tool coordinates)	Maximum amount of movement
X, Y directions	Until the marker leaves the angle of view in the +X, -X, +Y, and -Y directions to become undetectable
Z direction	+100 mm
A, B directions	±15°
C direction	±90°

Table 7-6: Robot calibration execution procedure

No.	Execution procedure	Item
1	Create a calibration program.	[Create Program] button
2	Reduce speed OVRD to 10% or lower.	[OVRD] button
3	Turn on the robot servos.	[SVO ON] button
4	Hold the teaching pendant and keep your finger over the stop button to ensure that the robot can be stopped at any time, and then start automatic operation of the calibration program with the robot controller.	[START] button
5	Stop calibration if the need to do so arises during calibration.	[STOP] button
6	After stopping the calibration, turn off the robot servos.	[SVO OFF] button
7	To execute the program from the start after stopping calibration, reset the program and execute calibration again.	[RESET] button

◇◆◇ Precautions regarding calibration programs ◇◆◇
Selecting [Create Program] will save the program in slot 1. To edit the calibration program, click [Home] → [Update] in RT ToolBox3. The created program will appear in the project tree.

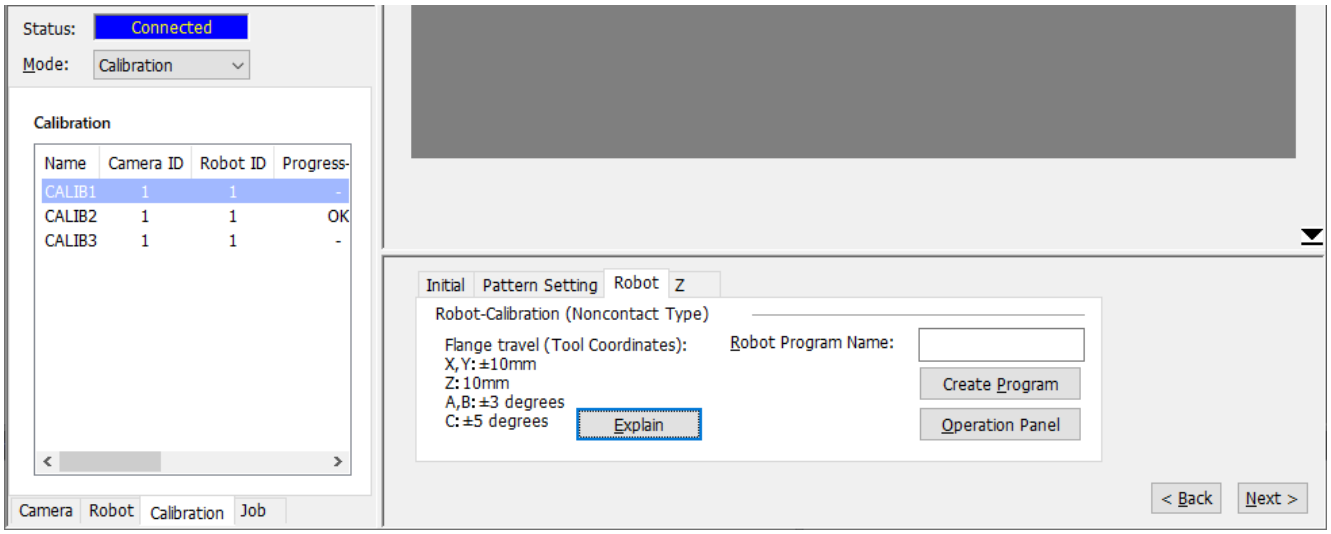


Fig.7-10 Robot calibration execution screen

Table 7-7: Explanation of the items on the Robot calibration execution screen

Item	Description
Flange travel (Tool Coordinates)	The step size of the robot that moves in search of the marker during calibration Example) X, Y, Z: 10 mm → The flange moves in the +X direction of the tool coordinates 10 mm at a time. When the last marker recognition is successful, the robot position and marker imaging result are acquired.
Explain	Displays the window explaining about the flange travel distance mentioned above.
Robot Program Name	Specifies the name of the calibration program that is automatically created.
Create Program	Automatically creates a calibration program.
Operation Panel	Opens the operation panel.

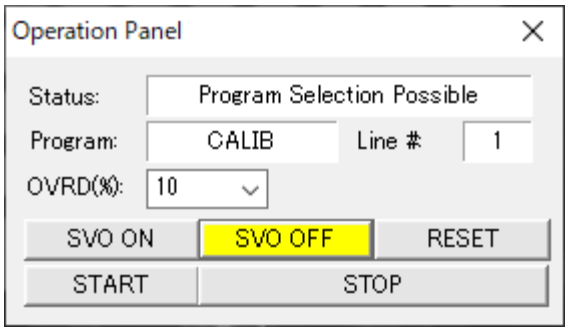


Fig.7-11 Operation panel for robot calibration

Table 7-8: Explanation of the items on the operation panel

Item	Description
OVRD	Select the override value (%) of the robot during auto calibration from the drop-down box.
START	Starts calibration.
STOP	Stops calibration.
SVO ON	Turns on the robot servos.
SVO OFF	Turns off the robot servos.
RESET	Resets errors or programs.

When the operation panel opens, the following caution message will appear. Pay attention to the length of the camera installation jig and interference with surrounding objects, then press the [START] button to execute calibration.

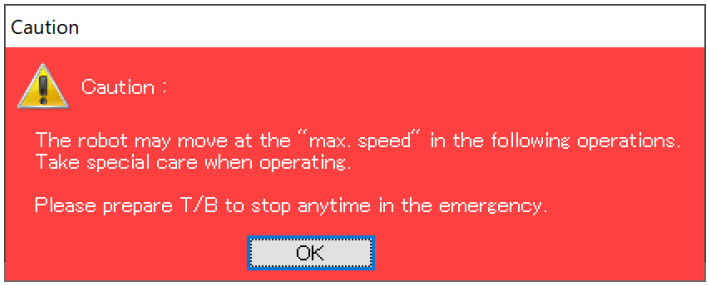
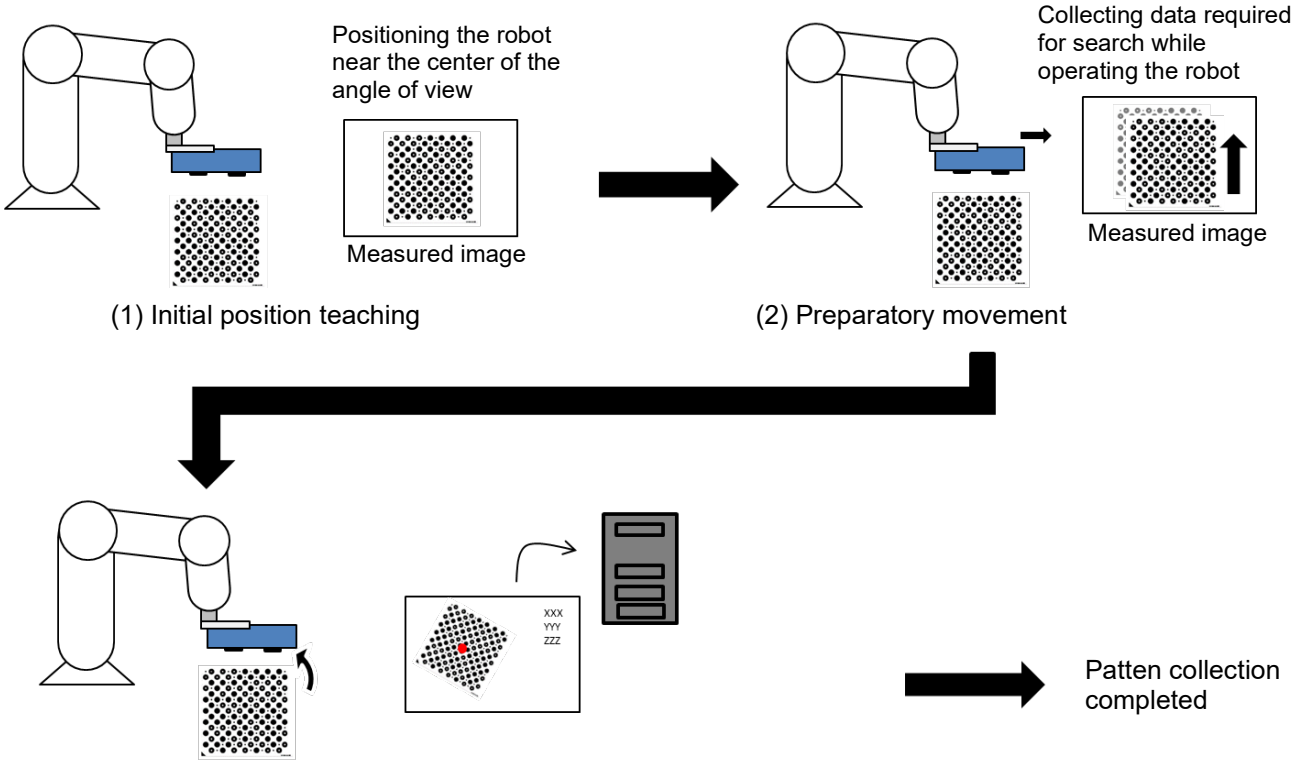


Fig.7-12 Robot calibration caution message

■ Auto calibration procedure
Auto calibration is completed by proceeding the phases from 1 to 3 as shown below.

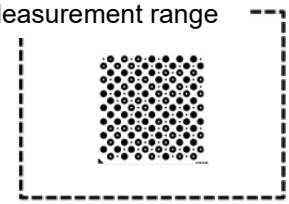


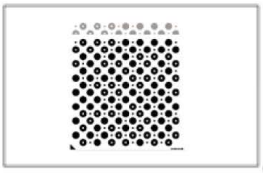
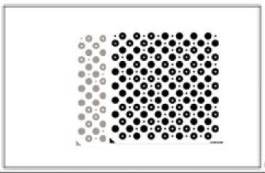
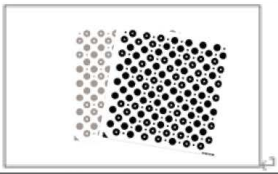
(3) Automatically searching for the marker position best for sampling and collecting the coordinates (X, Y, Z, A, B, and C directions).

Fig.7-13 Auto calibration procedure

■ Details of the robot's movement during auto robot calibration

<table>
<tr><th>Phase</th><th>Description</th></tr>
<tr><td>(1) Initial position teaching</td><td>1. Set the current tool coordinates so that the XY plane of the tool coordinates and the XY plane of the camera coordinates are parallel.

2. Position the marker as shown below so that the following conditions are satisfied.
• Each side of the marker is approximately parallel (within 5 degrees) to its corresponding side of the angle of view.
• The center of the marker is seen near the center of the angle of view.
Measurement range
 
3. Select [Create Program] and open the operation panel. Check that the servos are on and select [START].

* It is essential that OVRD is set to 10% or lower.
* Selecting [Create Program] will create a program in [Project] → [Online] in RT ToolBox3. By executing this program from the RT ToolBox3 operation panel, auto calibration can be performed.</td></tr>
<tr><td>(2) Preparatory movement</td><td>The robot makes a small movement in each travel distance in the following order.
<table>
<tr><th>Step</th><th>Robot operation</th><th>Travel distance (tool)</th></tr>
<tr><td>(1)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+X direction: 10 mm</td></tr>
<tr><td>(2)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+Y direction: 10 mm</td></tr>
<tr><td>(3)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+C direction: 5°</td></tr>
</table>
* If marker recognition fails in step 1, 2, or 3, an error will occur.
(14.4 MELFA-3D Vision Error Code Details)</td></tr>
<tr><td>(3) Marker search</td><td>The robot moves the following travel distance at a time in each axis direction. The following table shows the movements repeated by the robot.
X, Y directions (tool): ±10 mm
Z directions (tool): +10 mm
A, B directions (tool): ±3°
C direction (tool): ±5°

* Maximum travel distance (tool):
X, Y directions: Continues to move until the marker leaves the angle of view.
Z direction: +100 mm
A, B directions: ±15°
C direction: ±90°

<table>
<tr><th>Step</th><th>Robo operation</th><th>Robot travel distance (tool)</th></tr>
</table></td></tr>
</table>

(1)	1. Moves to the initial position and performs marker imaging.	None (initial position)
(2)	1. Moves to the initial position. 2. Moves the travel distance shown on the right and performs imaging. 3. Repeats step 2. 4. Moves to the position where the last marker recognition is successful in step 3, and performs imaging.	+X direction: 10 mm
(3)	↑	-X direction: 10 mm
(4)	↑	+Y direction: 10 mm
(5)	↑	-Y direction: 10 mm
(6)	↑	+Z direction: 10 mm
(7) Note 1	1. Moves to the initial position. 2. Moves the travel distance shown on the right and performs imaging. 3. Repeats step 2. 4. Searches the surrounding area if marker recognition fails in step 3. Goes back to step 2 when marker recognition is successful during the search. Search range in the surrounding area (X and Y directions in the tool coordinates): -10 mm to +10 mm from the robot position where recognition failed 5. Performs imaging at the position where the last marker recognition is successful if the maximum travel distance is reached in step 3, or the marker is not found during the search in step 4. (End of the flow)	+A direction: 3°
(8) Note 1	↑	-A direction: 3°
(9) Note 1	↑	+B direction: 3°
(10) Note 1	↑	-B direction: 3°
(11)	↑	+C direction: 5°
(12)	↑	-C direction: 5°

Note 1: Steps 7 through 10 are not performed for robots other than vertical 6-axis robots.

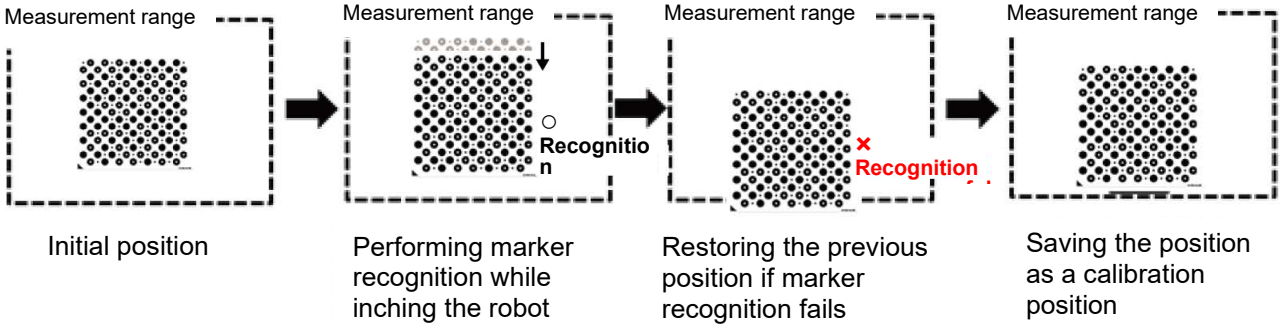


Fig.7-14 Outline of marker movement within the angle of view in phases 2 to 6

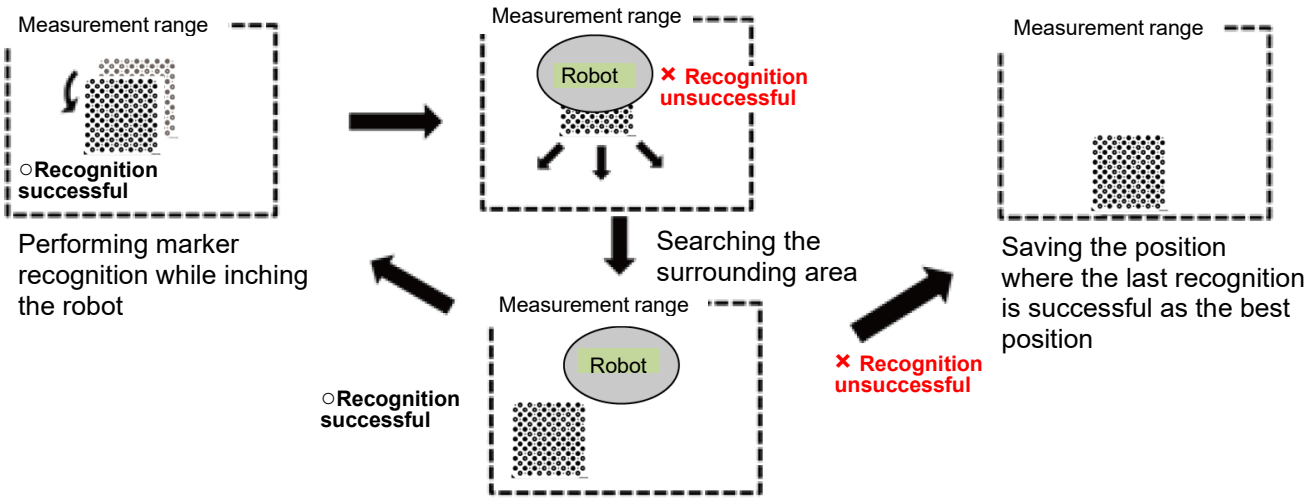


Fig.7-15 Outline of marker movement within the angle of view in phases 7 to 12

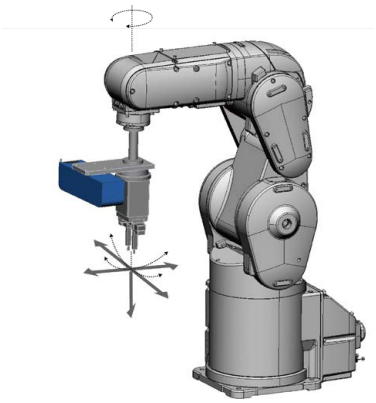


Fig.7-16 Example of robot operation during calibration

In each phase, if marker recognition fails, an error will occur ("14.4 MELFA-3D Vision Error Code Details"). Adjust the robot and marker positions. In particular, check the robot's initial position and operating range.

After marker recognition is successful in all the 12 postures, the screen shown in "Fig.7-17" will appear. Finish robot calibration by judging the displayed calibration deviation (mm)
Calibration deviation reference value
Deviation after calibration under the following conditions: 0.210
Camera: N35-804-16-IR
Robot: RV-7FR-D
Distance from the camera to the marker: 800 mm
Calibration plate/pattern: AL00091
Plate area relative to the angle of view: 1/2

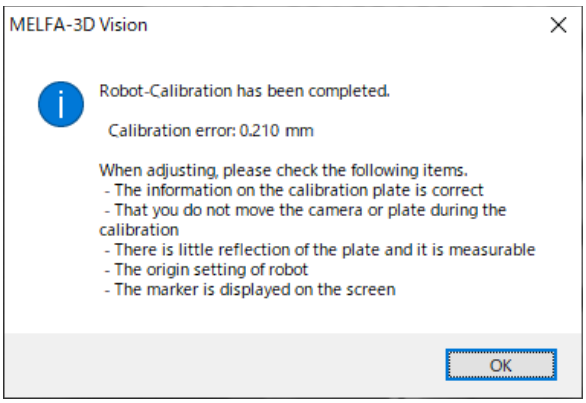


Fig.7-17 Robot calibration completed screen (for vertical 6-axis robots)

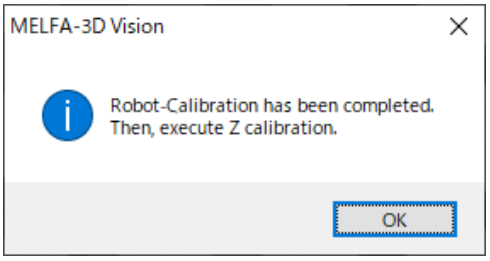


Fig.7-18 Robot calibration completed screen (for robots other than vertical 6-axis robots)

If the robot is stopped during calibration, and the calibration is restarted after the robot is repositioned, M_V3Rslt(x) (x: Storage destination No.) is substituted by 33, which may stop the program. In this case, restarting the program will execute robot calibration from the start. To restart the program that is stopped, do not change the robot position from when the calibration is stopped until when it is restarted.
If robot calibration fails, check the following and perform robot calibration again.

Table 7-9: Check items when calibration fails

No.	Check item	Solution
1	Is there any ambient light [Note 1]?	Block any ambient light.
2	When the robot is taught its initial position, is the calibration marker positioned within the range shown in Fig.7-8?	Move the robot using Jog operation so that the calibration marker is positioned within the range shown in Fig.7-8.
3	Was the camera or a calibration marker moved during calibration?	If moved, reteach the calibration posture.
4	Is the robot calibration plate shining due to specular reflection?	Change the calibration posture to a position with no specular reflection.
5	Is the robot origin setting correct?	Set the origin again. * Refer to the instruction manual, "Robot Arm Setup and Maintenance".
6	(For robots other than vertical 6-axis robots) Is the Z calibration accuracy high enough?	Perform Z calibration again.
7	M_V3Rslt(x) (x: Storage destination No.) substituted by one of 3105 to 3110? (Refer to Note 2 in "14.5 Q&A".)	Marker recognition fails during calibration. Check if the point group of all markers is seen within the angle of view in each posture of the robot that is moving in different axis directions.
8	Is the value of M_V3Rslt(x) (x: Storage destination) No. 33?	Check No.10 in "14.5 Q&A".

Note 1: It includes general lighting such as room illumination.

Note 2: After stopped, the calibration cannot be restarted. Move the robot back to its initial position and perform calibration again.
If error L3142, L8610, or L8632 occurs during calibration, refer to No. 3 to 5 in "14.5 Q&A".

◇◆◇If calibration fails◇◆◇

Angles are expressed in radians in the program. If parameter "PRGMDEG" is set to "1", measurement will not be successful.

Proceed to "8. Measurement and Recognition Settings" when the robot calibration is completed.

7.2.5. Non-contact type (fixed camera)

For non-contact type (fixed camera), the positional relationship between the camera and the robot is calculated. This is enabled by operating the robot and capturing images repeatedly while changing the postures of the calibration plate/pattern attached to the marker grasping jig.
Therefore, a marker grasping jig needs to be fabricated.

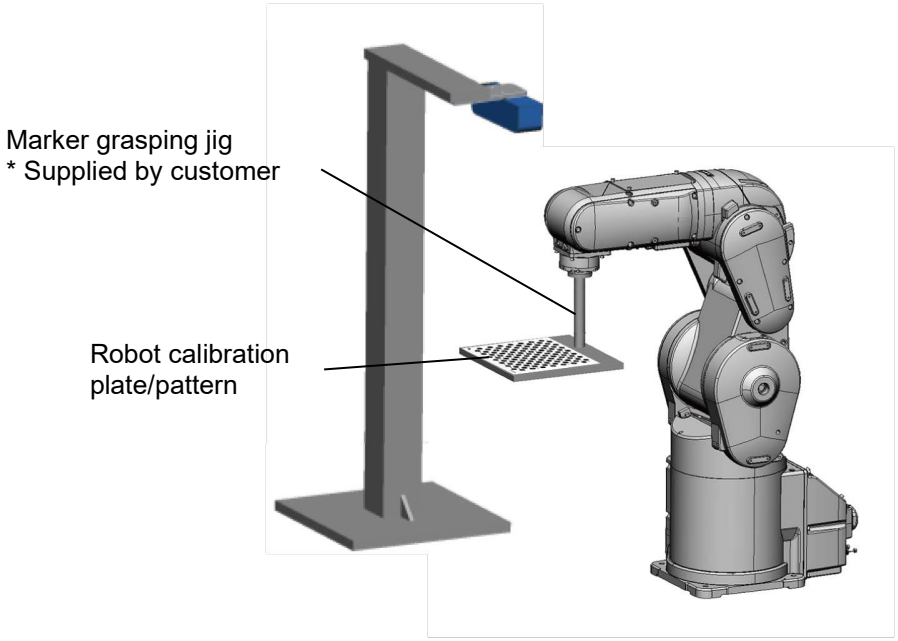


Fig.7-19 Example of attaching a robot calibration plate/pattern

◇◆◇Robot calibration plate attachment position◇◆◇
When attaching the robot calibration plate/pattern to a robot not equipped with a hand, make sure to attach the plate/pattern to the mechanical interface position or ahead.

■ Moving the robot to the initial position

Operate the robot to move it to a place where it can make big movements without interfering with surrounding objects. While checking the live images displayed on the screen, position the marker at the center of the camera angle of view. Note 1

Note 1: Imaging performed by the camera lens is used for live images (Refer to "2.4.2 Name of each part".).

Ensure that the distance between the marker and camera head is about the same as the working distance intended in the actual operation. Note 1

Note 1: By doing so, the depth of focus (condition of focus) will be equal between during calibration and in the actual operation.

Make sure that the optical axis of the camera and the marker are vertical to each other. When the following conditions are satisfied, they can easily become vertical by hand alignment.

- The robot installation surface is parallel to the XY plane in the camera coordinate system.
- The marker is parallel to one of the XY plane, YZ plane, or ZX plane in the robot tool coordinate system.

◇◆◇ Base and tool settings ◇◆◇

Changing the base or tool settings from the default values will not affect robot calibration. Note 1

Note 1: The marker must be seen under the following conditions.

- The current tool coordinates are set so that the XY plane of the tool coordinates and the XY plane of the camera coordinates are parallel.
- Each side of the maker is almost parallel (within 5 degrees) to its corresponding side of the angle of view. (Fig.7-21 Live image in the initial robot position (example))
- The center of the marker is seen near the center in the 1/2 area of the angle of view.

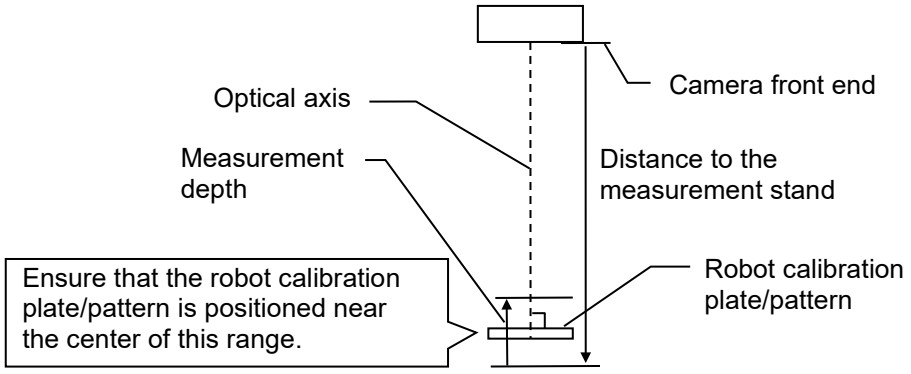


Fig.7-20 Distance to the calibration plate/pattern

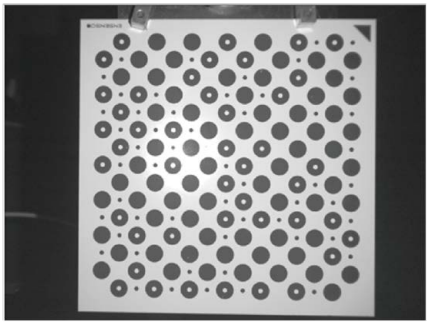


Fig.7-21 Live image in the initial robot position (example)

■ Executing the calibration program
In the setting/operation field, click the "Robot" tab to display the "Robot-Calibration (Noncontact Type)" window. Then, perform the steps in "Table 7-11: Robot calibration execution procedureTable 7-11: " to execute the program.
* RT ToolBox and the robot controller need to be connected online.
Before starting automatic operation, make sure that there are no obstacles in the surroundings. Be aware of the override speed.
If communication cannot be established properly among the camera, robot, and control unit, automatic operation may stop.
The time it takes to run the calibration program depends on the field of view size (mm × mm) and calibration plate/pattern area relative to the angle of view. As the area ratio is higher, the running time becomes shorter.
[Approximate running time]
In the following conditions, it takes approximately 15 minutes when O/P OVRD is set to 10%, and approximately 8 minutes when O/P OVRD is set to 30%.
Camera: N35-802-16-IR
Robot: RV-5AS
Calibration plate/pattern: AL00091
Plate area relative to the angle of view: approximately 1/2

■ Robot operating range
During calibration, the robot will move the following amount at maximum. Be aware of the length of the marker holding tool and prevent interference with surrounding objects.

Table 7-10: Robot operating range

Operation direction (tool coordinates)	Maximum amount of movement
X, Y directions	Until the marker leaves the angle of view in the +X, -X, +Y, and -Y directions to become undetectable
Z direction	+100 mm
A, B directions	±15°
C direction	±90°

Table 7-11: Robot calibration execution procedure

No.	Execution procedure	Item
1	Create a calibration program.	[Create Program] button
2	Reduce speed OVRD to 10% or lower.	[OVRD] button
3	Turn on the robot servos.	[SVO ON] button
4	Hold the teaching pendant and keep your finger over the stop button to ensure that robot can be stopped at any time, and then start automatic operation of the calibration program with the robot controller.	[START] button
5	Stop calibration if a need to do so arises during calibration.	[STOP] button
6	After stopping the calibration, turn off the robot servos.	[SVO OFF] button
7	To execute the program from the start after stopping calibration, reset the program and execute calibration again.	[RESET] button

◇◆◇ Precautions regarding calibration programs ◇◆◇
Selecting [Create Program] will save the program in slot 1. To edit the calibration program, click [Home] → [Update] in RT ToolBox3. The created program will appear in the project tree.

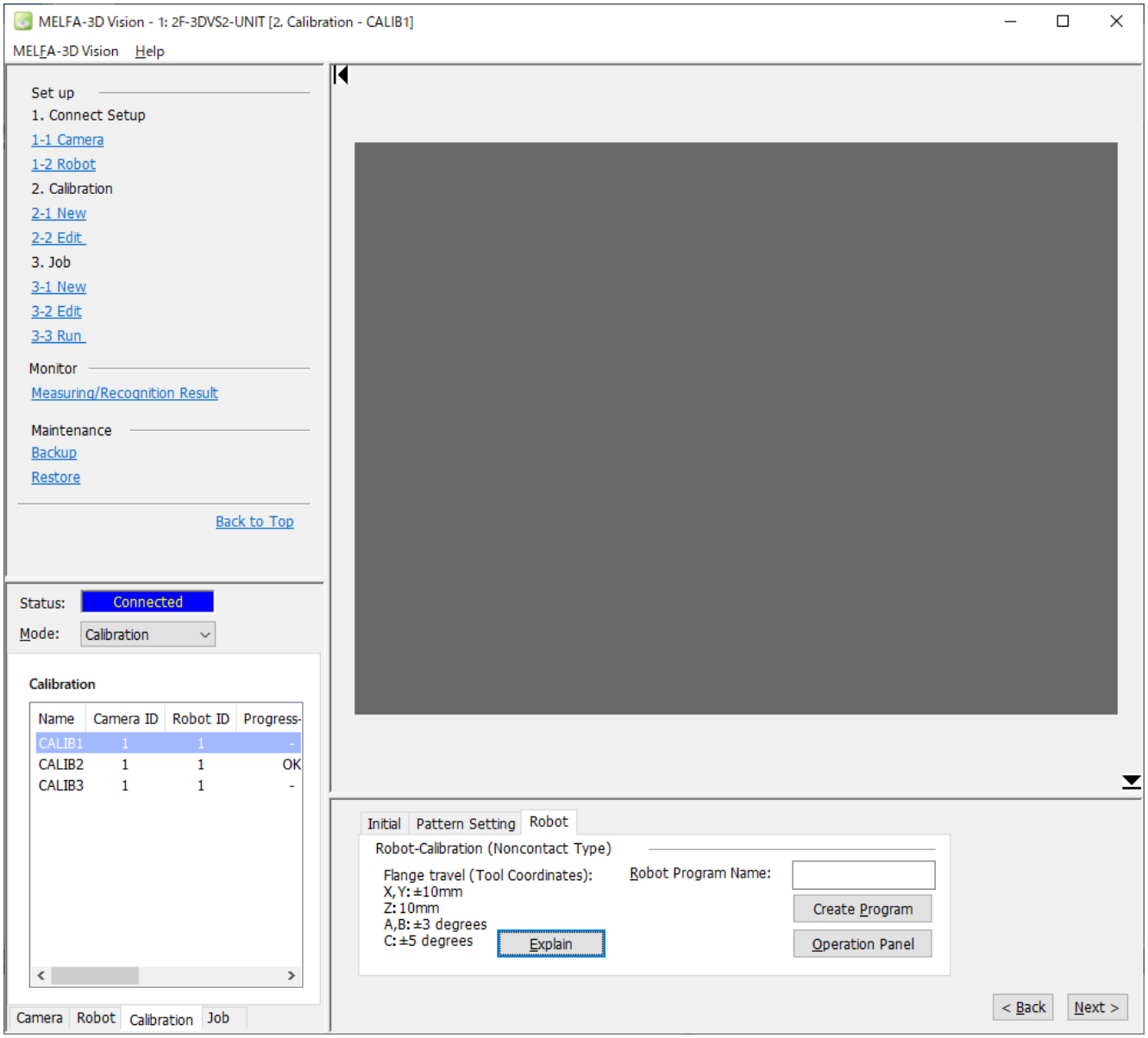


Fig.7-22 Robot calibration execution screen

Table 7-12: Explanation of the items on the Robot calibration execution screen

Item	Description
Flange travel (Tool Coordinates)	The step size of the robot that moves in search of the marker during calibration Example) X, Y, Z: 10 mm → The flange moves in the +X direction of the tool coordinates 10 mm at a time. When the last marker recognition is successful, the robot position and marker imaging result are acquired.
Explain	Displays the window explaining about the flange travel distance mentioned above.
Robot Program Name	Specifies the name of the calibration program that is automatically created.
Create Program	Automatically creates a calibration program.
Operation Panel	Opens the operation panel.

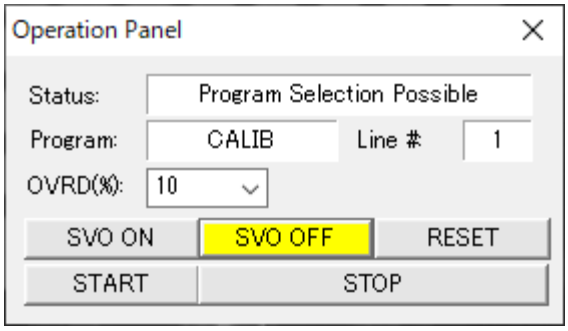


Table 7-23: Operation panel

Table 7-13: Explanation of the items on the operation panel

Item	Description
OVRD	Select the override value (%) of the robot during auto calibration from the drop-down list.
START	Starts calibration.
STOP	Stops calibration.
SVO ON	Turns on the robot servos.
SVO OFF	Turns off the robot servos.
RESET	Resets errors or programs.

When the operation panel opens, the following caution message will appear. Be careful of the length of the camera mounting jig and surrounding objects and press the [START] button to execute calibration.

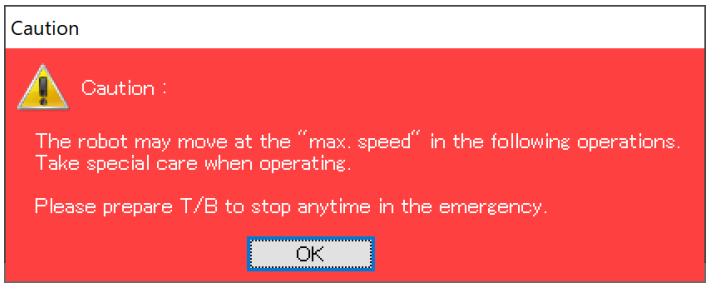
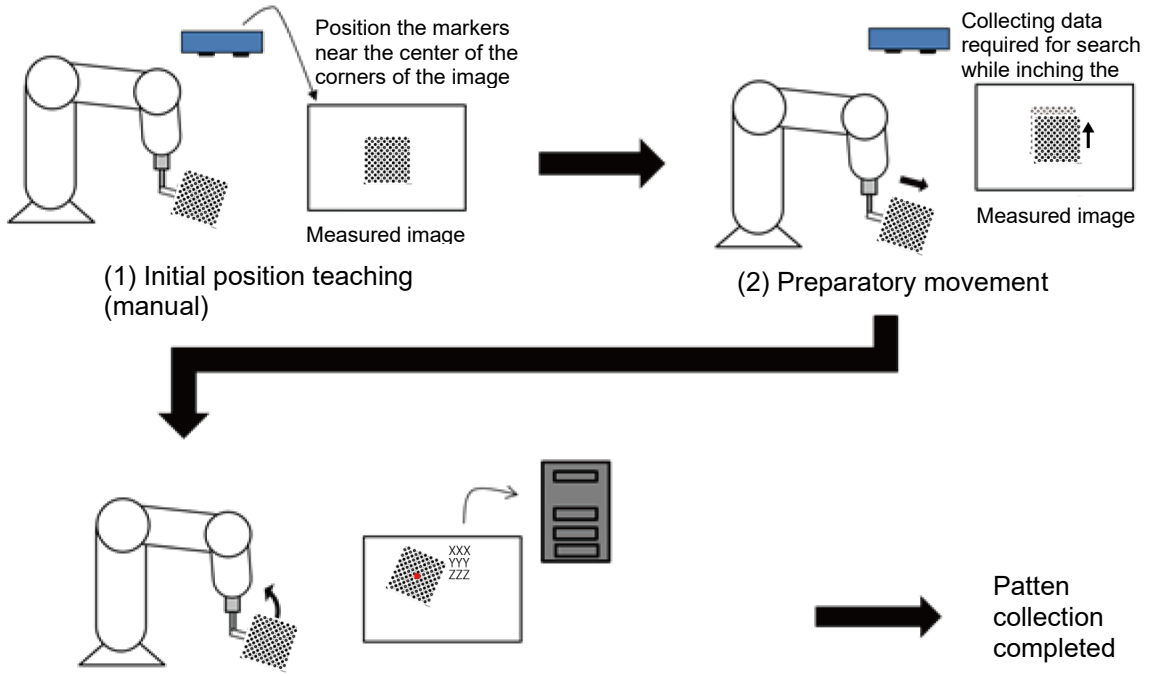


Fig.7-24 Robot calibration caution window

■ Auto calibration procedure

Auto calibration is completed by proceeding the phases from 1 to 3 as shown below.



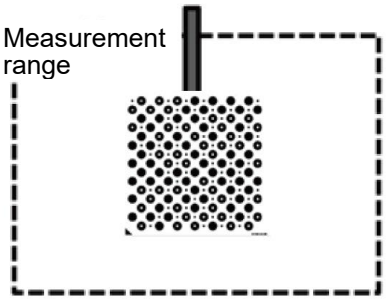
(1) Initial position teaching (manual)

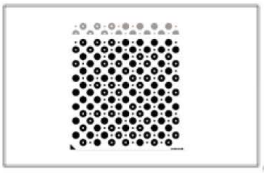
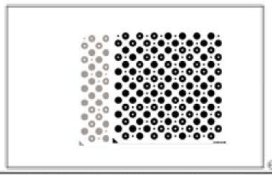
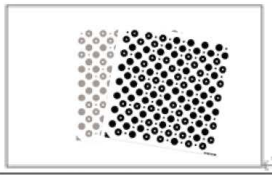
(2) Preparatory movement

(3) Automatically searching for the marker position best for sampling and collecting the coordinates (X, Y, Z, A, B, and C directions)

Fig.7-25 Auto calibration procedure

■ Details of the robot's movement during auto robot calibration

<table>
<tr><th>Phase</th><th>Description</th></tr>
<tr><td>(1) Initial position teaching</td><td>1. Set the current tool coordinates so that the XY plane of the tool coordinates and the XY plane of the camera coordinates are parallel.
2. Position the marker as shown below so that the following conditions are satisfied.
• Each side of the maker is almost parallel (within 5 degrees) to its corresponding side of the angle of view.
• The center of the marker is seen near the center of the angle of view.
 
3. Select [Create Program] and open [Operation Panel]. Check that the servos are on and select [START].

* Note that OVRD is set to 10% or lower.
* Selecting [Create Program] will create a program in [Project] → [Online] in RT ToolBox3. By executing this program from the RT ToolBox3 operation panel, auto calibration can be performed.</td></tr>
<tr><td>(2) Preparatory movement</td><td>The robot makes a small movement in each travel distance in the following order.
<table>
<tr><th>Step</th><th>Robot operation</th><th>Travel distance (tool)</th></tr>
<tr><td>(1)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+X direction: 10 mm</td></tr>
<tr><td>(2)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+Y direction: 10 mm</td></tr>
<tr><td>(3)</td><td>Moves the travel distance shown on the right and performs imaging.
  </td><td>+C direction: 5°</td></tr>
</table>
* If marker recognition fails in step 1, 2, or 3, an error will occur.
(14.4 MELFA-3D Vision Error Code Details)</td></tr>
<tr><td>(3) Marker search</td><td>The robot moves the following travel distance at a time in each axis direction. The following table shows the movements repeated by the robot.
X, Y directions (tool): ±10 mm
Z directions (tool): +10 mm
A, B directions (tool): ±3°
C direction (tool): ±5°

* Maximum travel distance (tool):
X, Y directions: Continues to move until the workpiece leaves the angle of view.
Z direction: +100 mm
A, B directions: ±15°
C direction: ±90°

<table>
<tr><th>Phase</th><th>Robot operation</th><th>Robot travel distance (tool)</th></tr>
</table></td></tr>
</table>

(1)	1. Moves to the initial position and performs marker imaging.	None (initial position)
(2)	1. Moves to the initial position. 2. Moves the travel distance shown on the right and performs imaging. 3. Repeats step 2. 4. Moves to the position where the last marker recognition is successful in step 3, and performs imaging.	+X direction: 10 mm
(3)	↑	-X direction: 10 mm
(4)	↑	+Y direction: 10 mm
(5)	↑	-Y direction: 10 mm
(6)	↑	+Z direction: 10 mm
(7) Note 1	1. Moves to the initial position. 2. Moves the travel distance shown on the right and performs imaging. 3. Repeats step 2. 4. Searches the surrounding area if marker recognition fails in step 3. Goes back to step 2 when marker recognition is successful during the search. Search range in the surrounding area (X and Y directions in the tool coordinates): -10 mm to +10 mm from the robot position where recognition failed 5. Performs imaging at the position where the last marker recognition is successful if the maximum travel distance is reached in step 3, or the marker is not found during the search in step 4. (End of the flow)	+A direction: 3°
(8) Note 1	↑	-A direction: 3°
(9) Note 1	↑	+B direction: 3°
(10) Note 1	↑	-B direction: 3°
(11)	↑	+C direction: 5°
(12)	↑	-C direction: 5°
(13)	1. Moves to the initial position. 2. Moves the travel distance shown on the right from the position where phase 11 is completed, and performs imaging. 3. Repeats step 2. 4. Moves to the position where the last marker recognition is successful in step 3, and performs imaging. 5. Performs steps 1 to 4 for each of the two travel distances shown on the right	+X direction: 10 mm +Y direction: 10 mm
(14)	1. Moves to the initial position. 2. Moves the travel distance shown on the right from the position where phase 12 is completed, and performs imaging. 3. Repeats step 2. 4. Moves to the position where the last marker recognition is successful in step 3, and performs imaging. 5. Performs steps 1 to 4 for each of the two travel distances shown on the right	-X direction: 10 mm -Y direction: 10 mm

Note 1: Steps 7 through 10 are not performed for robots other than vertical 6-axis robots.

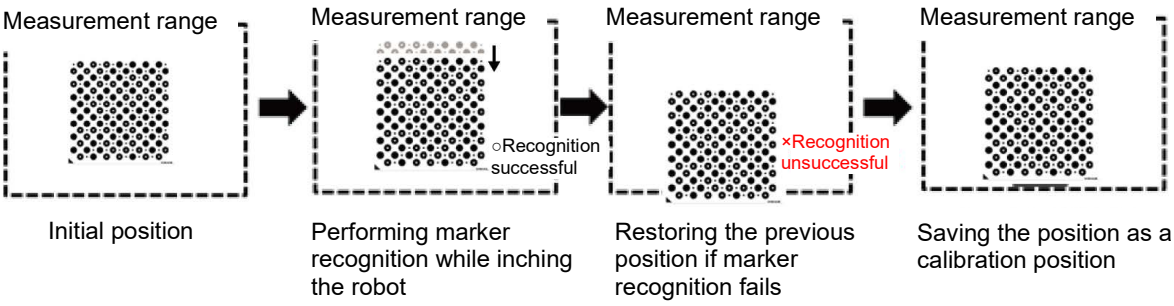


Fig.7-26 Outline of marker movement within the angle of view in phases 2 to 6

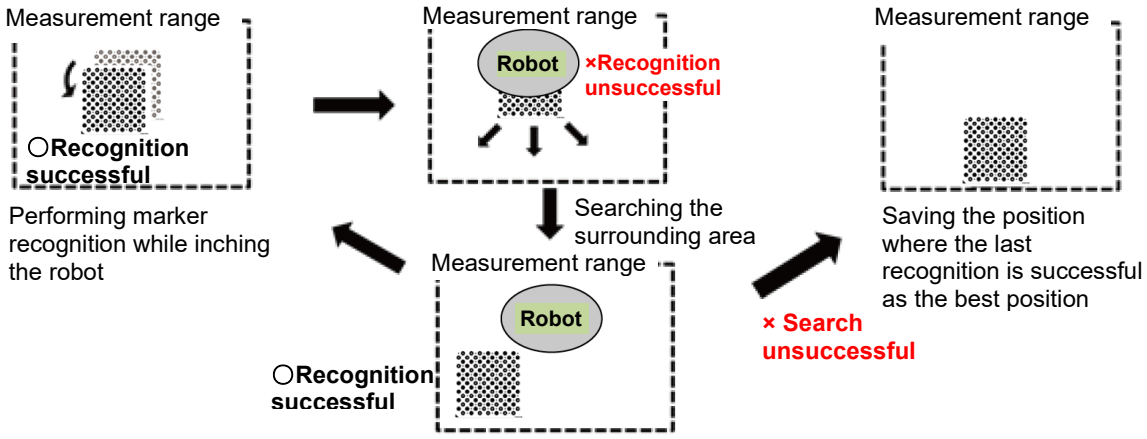


Fig.7-27 Outline of marker movement within the angle of view in phases 7 to 14

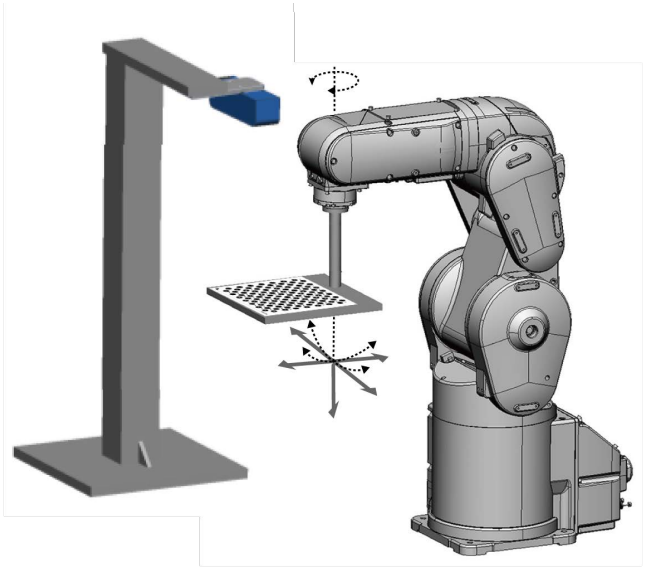


Fig.7-28 Example of robot operation during calibration

In each phase, if marker recognition fails, an error will occur ("14.4 MELFA-3D Vision Error Code Details"). Adjust the robot and marker positions. In particular, check the robot's initial position and operating range.

After marker recognition is successful in all the 14 postures, the screen shown in "Fig.7-29 " or “Fig.7-30 " will appear. Finish robot calibration by judging the displayed score.
Calibration deviation reference value
Deviation after calibration under the following conditions: 0.316
Camera: N35-804-16-IR
Robot: RV-7FR-D
Distance from the camera to the marker: 800 mm
Calibration plate/pattern: AL00091
Plate area relative to the angle of view: 1/2

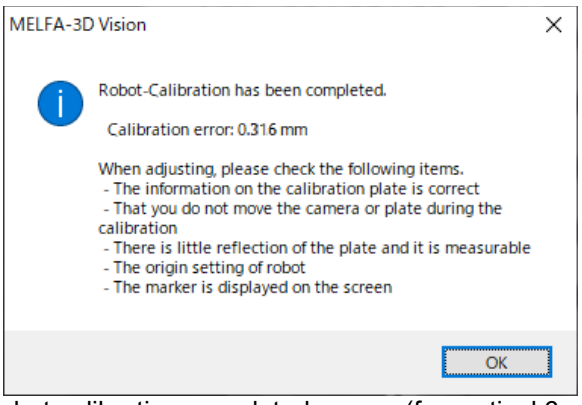


Fig.7-29 Robot calibration completed screen (for vertical 6-axis robots)

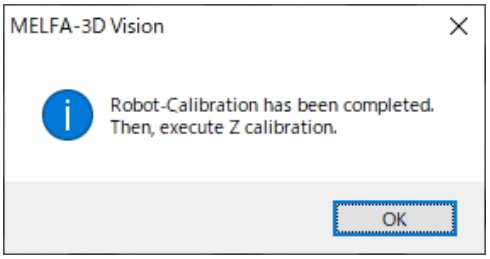


Fig.7-30 Robot calibration completed screen (for robots other than vertical 6-axis robots)

If the robot is stopped during calibration, and the calibration is restarted after the robot is repositioned, M_V3Rslt(x) (x: Storage destination No.) is substituted by 33, which may stop the program. In this case, restarting the program will execute robot calibration from the start. To restart the program that is stopped, do not change the robot position from when the program is stopped until when it is restarted.
If robot calibration fails, check the following and perform robot calibration again.

Table 7-14: Check items when calibration fails

No.	Check item	Remedy
1	Is there any ambient light [Note 1]?	Block any ambient light.
2	When the robot is taught its initial position, is the calibration marker positioned within the range shown in "Fig.7-20"?	Use Jog operation to position the calibration marker within the range shown in "Fig.7-20".
3	Was the camera or a calibration marker moved during calibration?	If moved, reteach the calibration posture.
4	Is the robot calibration marker shining due to specular reflection?	Change the calibration posture to a position with no specular reflection.
5	Is the robot origin setting correct?	Set the origin again. * Refer to the instruction manual, "Robot Arm Setup and Maintenance".
6	(For robots other than vertical 6-axis robots) Is the Z calibration accuracy high enough?	Perform robot calibration again.
7	Is M_V3Rslt(x) (x: Storage destination No.) substituted by one of 3105 to 3110? (Refer to "14.5 Q&A.")[Note 2]	Marker recognition fails during calibration. Check if the point group of all markers is seen within the angle of view in each posture of the robot that is moving in different axis directions.
8	Is the value of M_V3Rslt(x) (x: Storage destination) No. 33?	Check No.10 in "14.5 Q&A".

Note 1: It includes general lighting such as room illumination.
Note 2: After stopped, the calibration cannot be restarted. Move the robot back to its initial position and perform calibration again.

If error L3142, L8610, or L8632 occurs during calibration, refer to No. 3 to 5 in "14.5 Q&A".

◇◆◇ If calibration fails ◇◆◇

Angles are expressed in radians in the program. If parameter "PRGMDEG" is set to "1", measurement will not be successful.

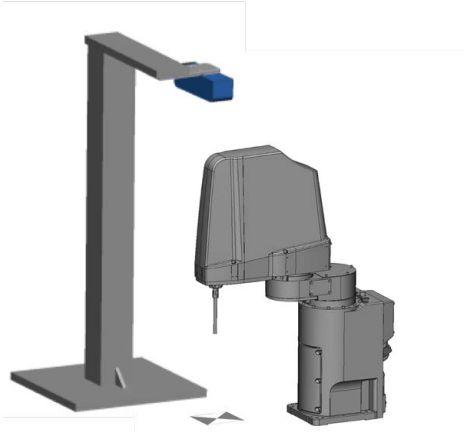
Proceed to "8 Measurement and Recognition Settings" when the robot calibration is completed.

7.2.6. Z calibration (for robots other than vertical 6-axis robots)

■ For vertical 6-axis robots
This process is not required. Robot calibration is complete. Proceed to "8 Measurement and Recognition Settings".
■ For other robots (horizontal 4-axis or vertical 5-axis robots)
To use non-contact type calibration for robots other than vertical 6-axis robots, Z calibration is required after the processes shown in section 7.2.4 or 7.2.5.
In this operation, component Z of the relative position between the robot and the camera is calculated. (Hereafter "Z calibration") * The accuracy of Z calibration is affected by the accuracy of teaching.

■ Z calibration execution procedure
* The order of steps 2 and 3 below is interchangeable.
1. Select the "Z" tab in the setting/operation field.

2. Perform marker recognition.
While checking live images, place a marker of the type shown in section 15.4 so that the entire marker is seen within the angle of view.



Check that the marker is seen in approximately 1/4 of the angle of view as shown in "Fig.7-31 ". Then, click the center point of the marker and move the red frame toward the center point of the marker.

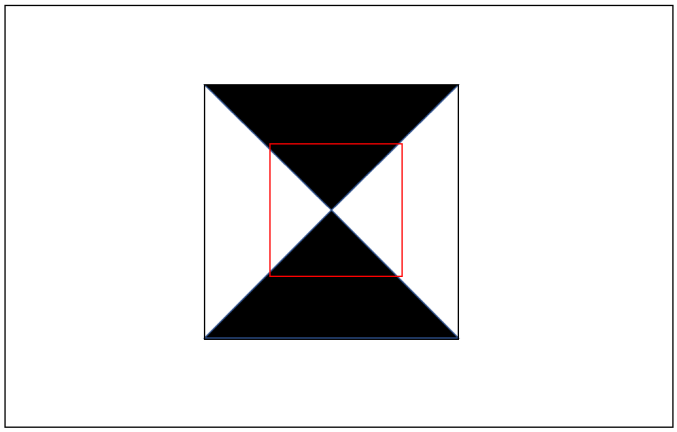


Fig.7-31 Layout of the marker and red frame

Select [Recognize] to perform marker recognition. When marker recognition is properly performed, "Camera Z result" in "Fig.7-33 Z calibration window" displays the Z coordinates of the marker's center point in the camera coordinate system. A mark resulting from the calibration is displayed in the center of the marker.
("Fig.7-32 Marker recognition successful status", "Fig.7-33 Z calibration window").

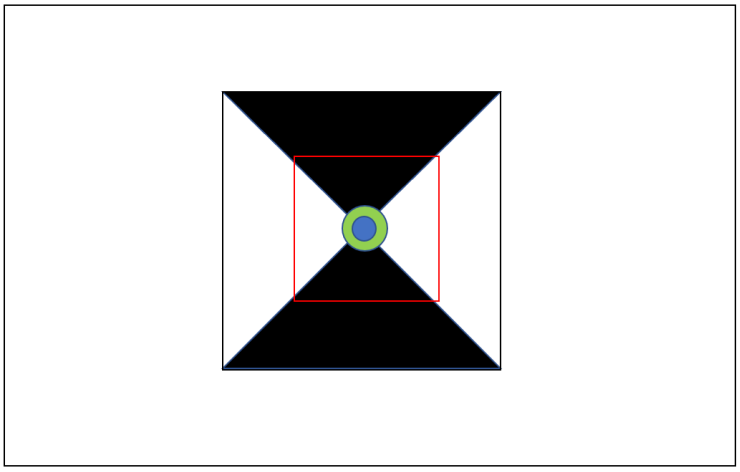


Fig.7-32 Marker recognition successful status

To reset the Z calibration information, press the [Reset] button. Then, the values under "Camera Z result", "Robot Z result", and "Result" are reset to empty.

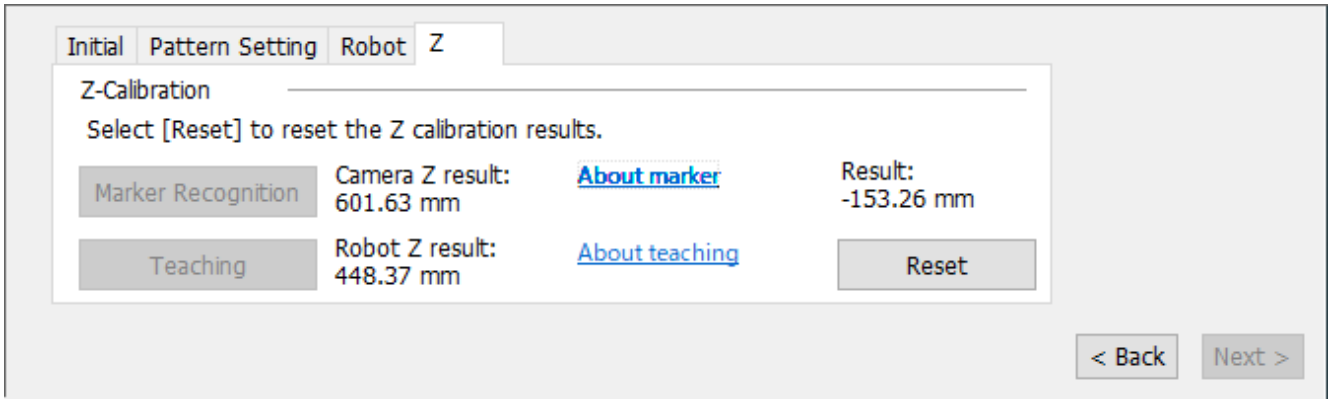


Fig.7-33 Z calibration window

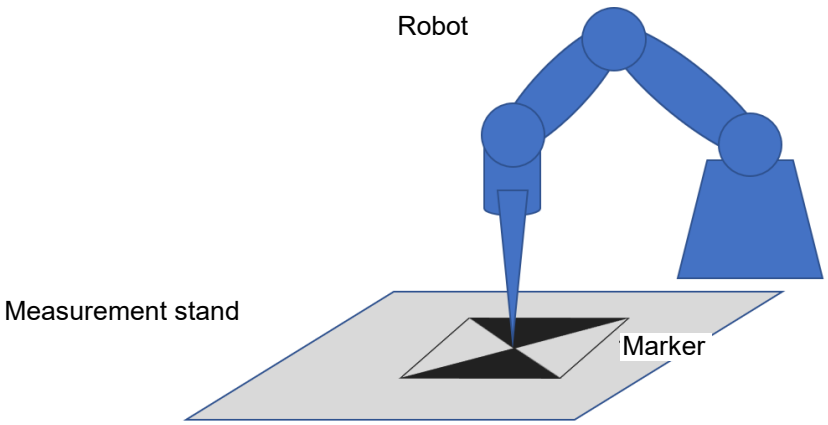
Table 7-15: Information displayed in the setting/operation field (Z calibration)

Item	Description
Explanation of the operation	Displays the explanation of the work performed by the user.
About marker	Click the text to display the image that explains marker recognition.
About teaching	Click the text to display the image that explains teaching.
Marker recognition	Click the button to substitute the value of the Z recognition result (camera) [mm] with the measured value.
Teaching	Click the button to substitute the value of the Z recognition result (robot) [mm] with the measured value.
Result [mm]	Click the [teach] button to display the Z calibration result.
Reset	Resets the Z calibration result to empty.

3. Perform teaching. In the "Z" tab, press the [Teaching] button while the tip of the robot arm touches the workbench as shown in the following figure. This displays the Z coordinates of the marker's center point in the robot coordinate system under "Robot Z result" in "Fig.7-33 Z calibration window".
The Z calibration result is displayed under "Result". When the result is displayed, the Z calibration is complete.

◇◆◇ Base and tool settings ◇◆◇
Changing the base or tool settings from the default values will not affect robot calibration. Note 1

Note 1: The current tool coordinates need to be set so that the XY plane of the tool coordinates and the XY plane of the camera coordinates are parallel.



◇◆◇ Precautions for the length tool with tapered top ◇◆◇
When non-contact type calibration is used for a robot other than a hand eye or vertical 6-axis robot, the marker must be within the working distance of the camera when the marker and the robot arm are brought in contact as shown in the above figure.

To reset the Z calibration information, press the [Reset] button. Then, the values under "Camera Z result", "Robot Z result", and "Result" are reset to empty.

7.2.7. Contact type

The contact-type robot calibration is available only for fixed cameras. This type that uses a fixed camera matches the robot coordinates and the camera coordinates by pointing the recognized mark with the tip of the robot arm. Therefore, configure the tool settings correctly for the tip of the robot arm.

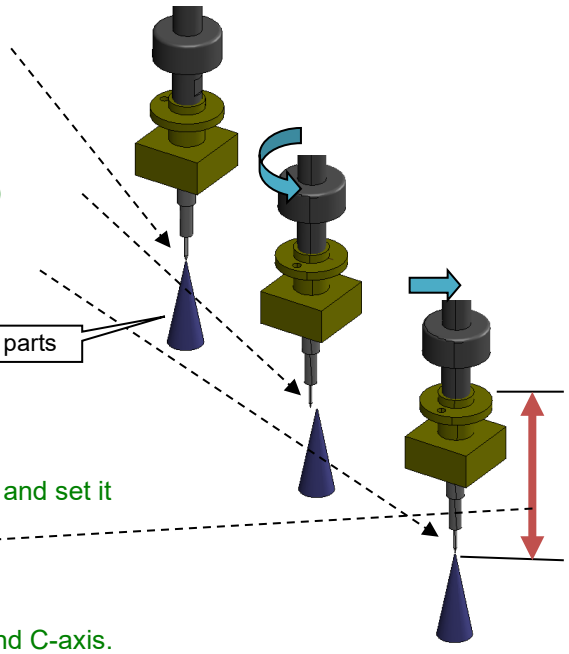
◇◆◇ Base and tool settings ◇◆◇

Changing the base or tool settings from the default values will not affect robot calibration.

■ Tool point setting operation

Next robot program will help you to calculating the tool point setting parameters. For this operation, you should prepare fixed tip parts around the robot hand. After loading this program to the robot, you can run this program step according to the comments and get the parameters.

```
Tool P_NTool
'Set the tool downward, move to the 1st position
P0=P_Fbc
P91=P0*(+0.00,+0.00,+0.00,+0.00,+0.00,+90.00)
Mvs P91
'Rotate 90 degrees (the hand moves to shifted position)
PTL=P_Zero
'Shift the hand according to XY-axis just above
 'the fixed tip parts
P90=P_Fbc
PT=Inv(P90)*P0
PTL.X=(PT.X+PT.Y)/2
PTL.Y=(-PT.X+PT.Y)/2
'Measuring the length between flange and hand tip part and set it
 'as next parameter.
PTL.Z=150
Tool PTL
'Check whether does the hand tip part rotates just around C-axis.
Hlt
End
```



■ Teach 5 calibration poses

The contact-type robot calibration for the fixed camera please put five marks or calibration sheet, in the field of view of the camera. In that time, please be placed so that the mark is within the red frame in the robot calibration screen. When you click the "mark recognition" button, center positions of each mark will be detected.

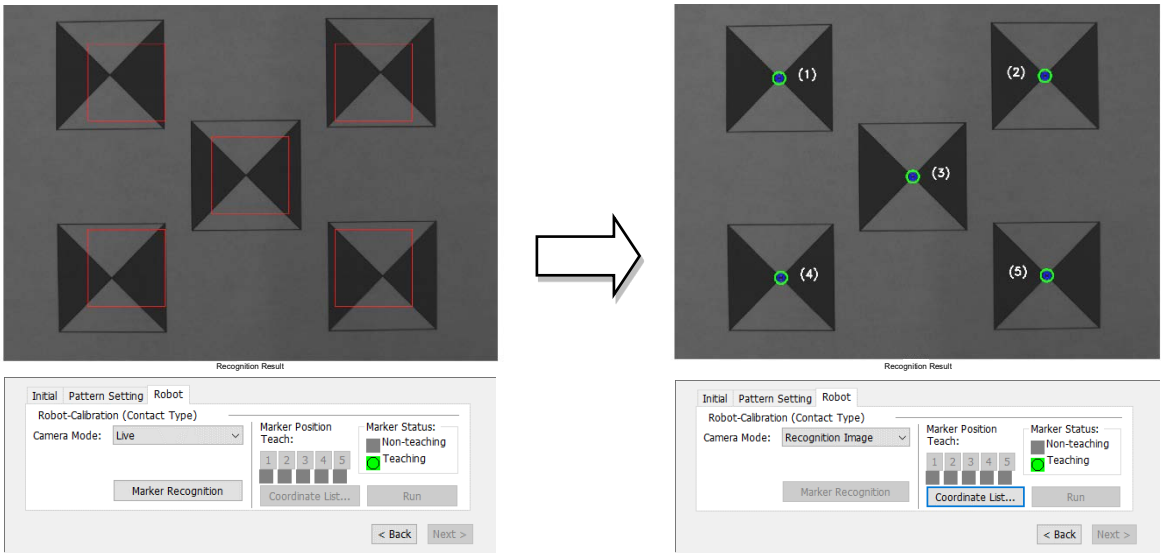


Fig. 7-34 Marker recognition

◇◆◇ When the mark is not within the red frame ◇◆◇

Click the red frame to move so that the center of the mark is within the red frame (Refer to Fig. 7-35).

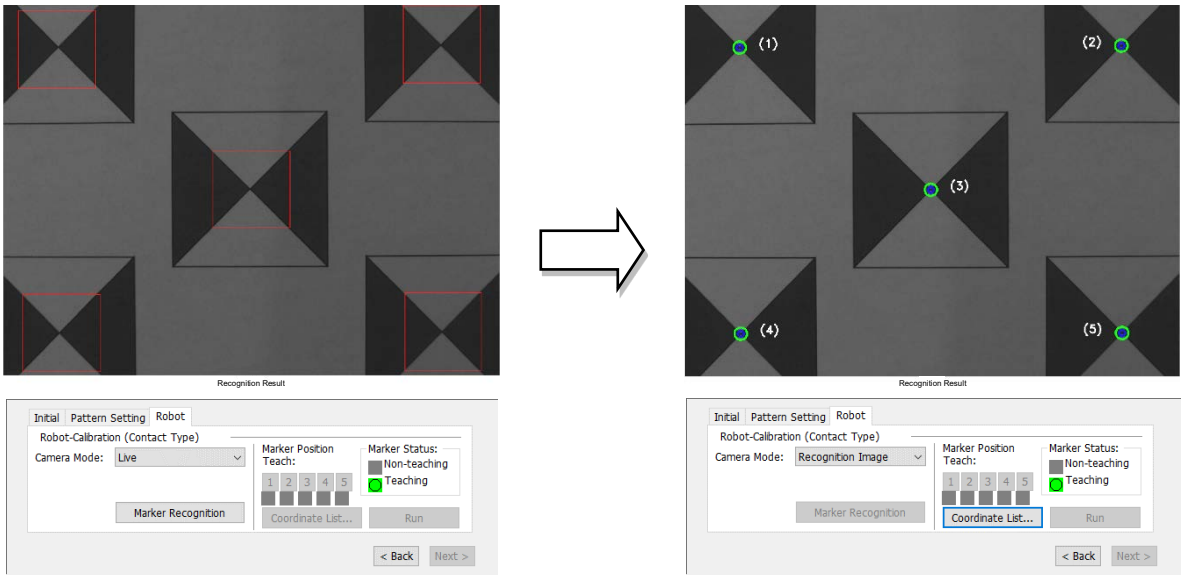


Fig. 7-35 Marker recognition (when the mark is not within the red frame)

After recognizing mark positions in image plane, to obtain robot positions by clicking the corresponding buttons with contacting each mark by the tip of the robot. After successful acquisition of each mark, each indicator will be changed to the "taught" position.

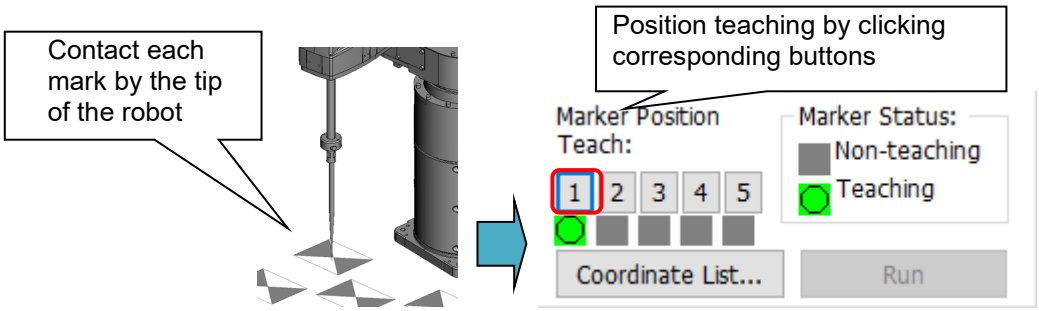


Fig. 7-36 Teaching operations at robot calibration

◇◆◇When a communication error with the robot occurs◇◆◇
The robot calibration will proceed with the communication with the robot, please complete the communication settings of the robot in advance.

Please repeat this operation to each mark.

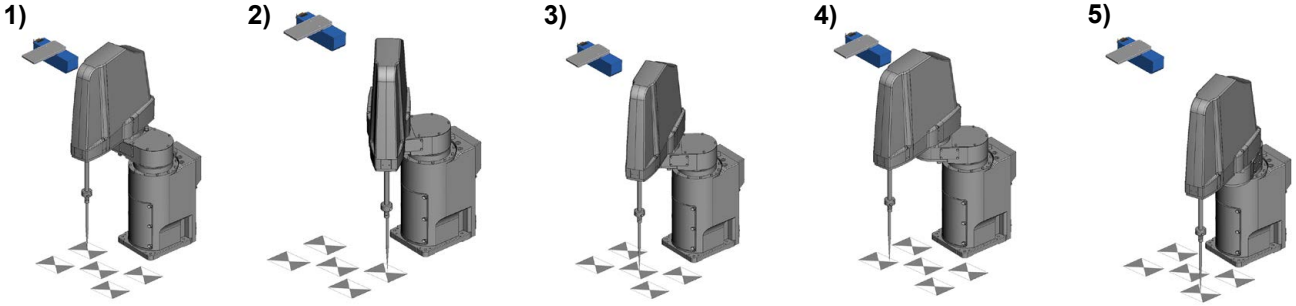


Fig. 7-37 Robot operation examples at robot calibrations

After teaching of all mark positions, the “Done” button will be ready. By clicking this button, the calibration parameters will be calculated.

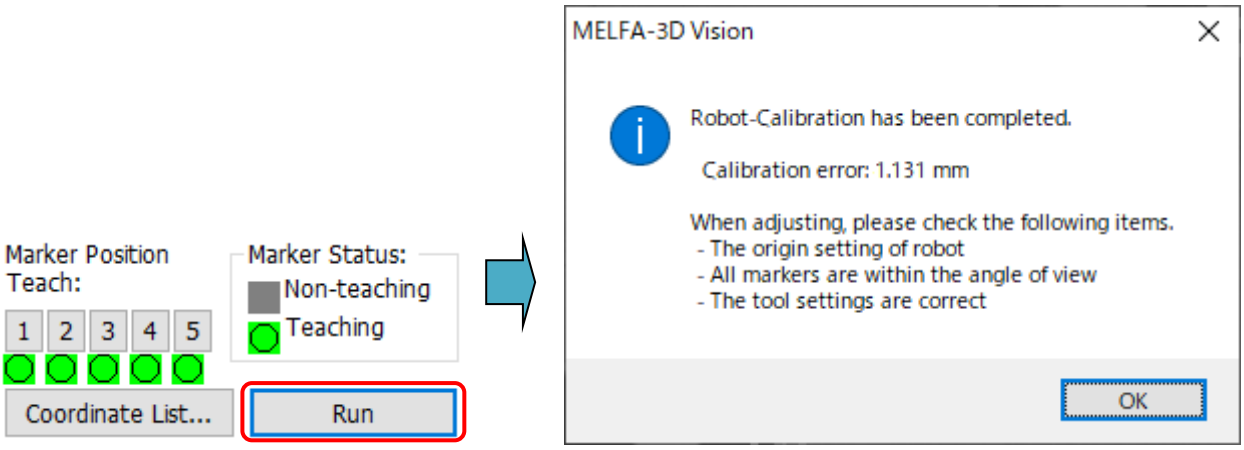
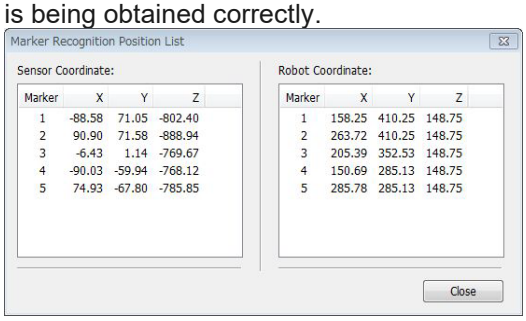


Fig. 7-38 Calculation of the robot calibration

Finish robot calibration by judging the displayed calibration deviation (mm).

When the robot calibration is failed, please check the following items.

Table 7-16 Check items when the robot calibration is failed

No.	Check items	Action
1	Is there disturbing light [Note 1]?	Please shut off the disturbing light.
2	Are the marks of robot calibration sheet recognized correctly?	Please check mark center is being recognized correctly. When there is a positional error of the mark, please display a live image and try again to recognize the mark. Also, please teach again the robot position with touching marks.
3	Please check calibration sheet or not moving in accordance with the operation to go pointing the robot tip end.	If the calibration sheet had moved, please repeat the series of operations.
4	Please open the "Recognized mark position list", and make sure whether the position of the robot is being obtained correctly.  	Please try again the robot calibration after eliminating reasons of the problem. Ex. - Mis-setting of tool parameters - Getting robot position data from different robot
5	Please check the origin position data of the robot	Please set again the origin position data of the robot * Please refer to the ROBOT ARM SETUP & MAINTENANCE.

Note 1: Ambient light (ex. room illumination) is a kind of the disturbing light.

7.3. Editing and deleting the calibration data

■ Editing existing calibration data

For editing the existing calibration data, by clicking [Startup] - [2. Calibration] - [2-2 Edit Data] in the guidance menu, a Calibration data selection screen appears. Select the calibration data to be edited and click the [Select] button.

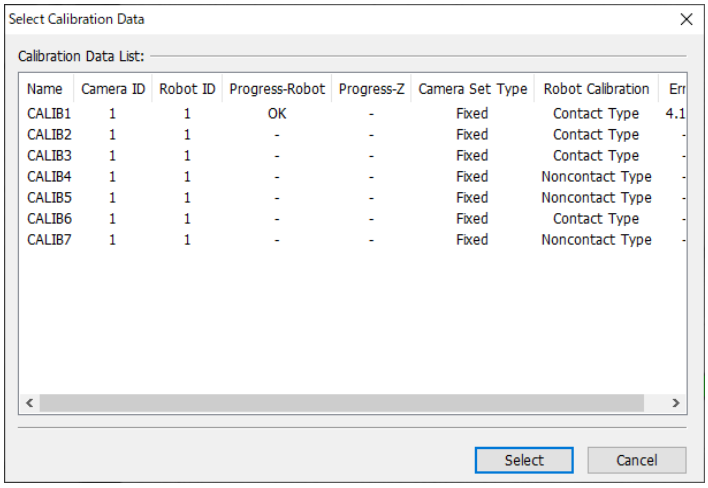


Fig. 7-39 Selection of calibration data

◇◆◇ Precautions regarding calibration programs ◇◆◇

It is possible to edit the calibration data of a created calibration program by opening the data file and select the calibration program in RT ToolBox3.

■ Changing the calibration data name

For changing the calibration data name, select the Calibration tab in the Properties window, right-click the applicable calibration data name to display the context menu, and then click [Rename] in the context menu to change the name.

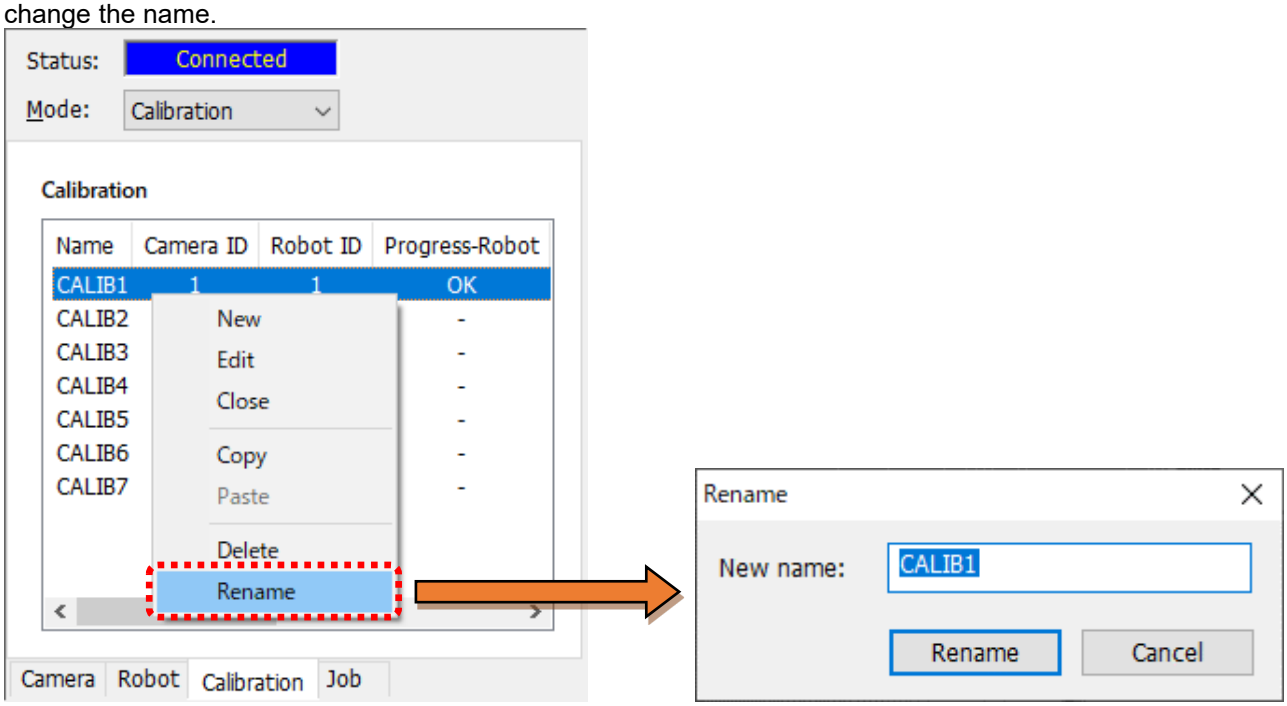


Fig. 7-40 Changing the calibration data name

■ Deleting calibration data

For deleting the calibration data, click [Delete] in the context menu. However, calibration data that is being edited cannot be deleted. To close the Edit screen, click [MELFA-3D Vision] - [Close calibration data] on the menu bar.

8. Measurement and Recognition Settings

Register the measurement and recognition conditions in the job. By clicking [3. Job] - [3-1 New] in the guidance menu of the MELFA-3D Vision setting screen, a Measurement/recognition screen appears.

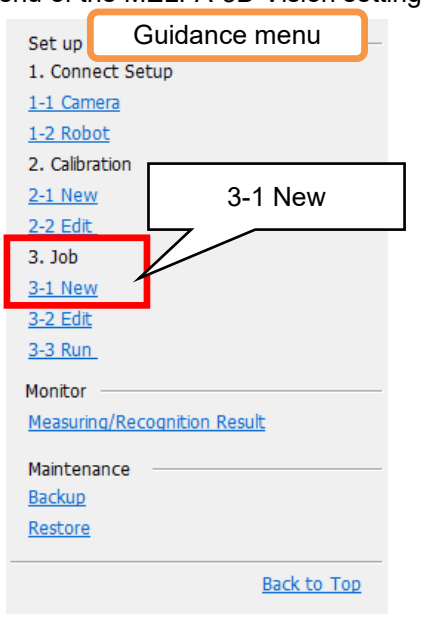


Fig. 8-1 Measurement/recognition

◇◆◇Creating new jobs◇◆◇
New jobs can be created by selecting from the context menu that appears when right-clicking the "Job" tab in the Properties window.

8.1. Selecting the workspace ID and the calibration data

To perform measurement and recognition, select the ID of the workspace to be used and the calibration data. The workspace is an area to temporarily retain the captured images and range images obtained when performing measurement and the results and recognition images obtained when performing recognition. Please note that the setting for the workspace ID selected here is not saved to the job. The selected workspace is used only when the [Measure] button is clicked in this screen.

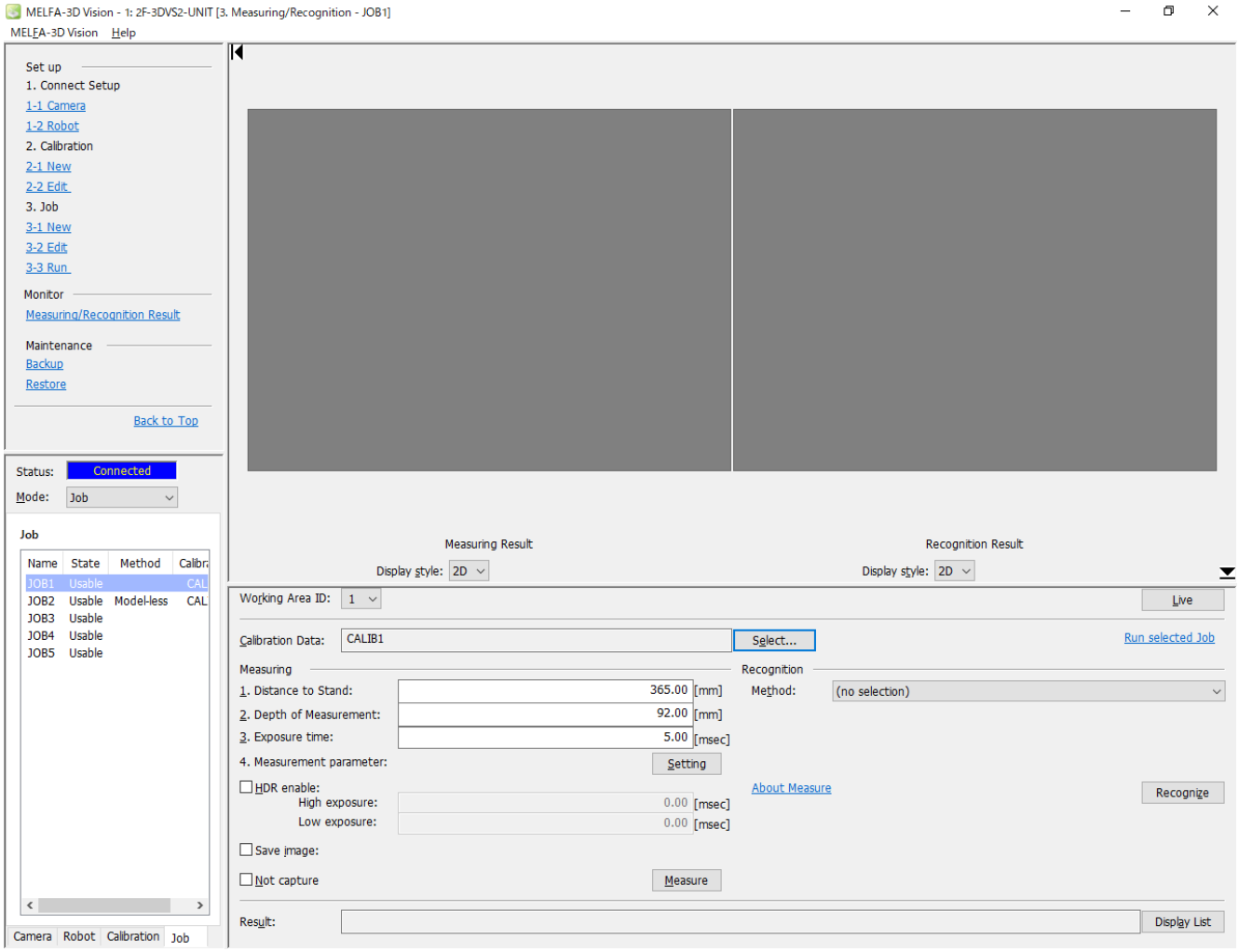


Fig. 8-2 Measurement and recognition settings

8.2. Measurement settings

In measurement processing, height information is generated in gray scale range images.
This section descries the measurement parameter settings required for measurement processing.
Configure the following settings and press the [Measure] button to execute measurement.
* The camera, when started, requires a longer measurement time for the first imaging than the measurement time described in the specifications.
* During measurement, do not look directly into the projecting part of the camera. If the light hits your eyes, damage may occur.

Table 8-1 Measurement parameters

No.	Item	Description	Remarks
1	Distance to Stand	Distance from the camera lens mounting base (camera front end flange surface) to the measurement stand	If misrecognition occurs by measuring the measurement stand or the bottom of the supply box, shorten the distance within the range in which workpiece measurement is possible to ensure that the measurement stand is not measured. (Particularly with suction hands)
2	Depth of Measurement	Target range of measurement based on the position specified at "Distance to measurement stand"	Determine the depth from the estimated workpiece stacking height. The accuracy is highest when the height from the measurement stand is about the same as the height during robot calibration.
3	Exposure time	Camera exposure time (time interval that a sensor is exposed to light, shutter speed)	
4	ENSENSO measurement parameters	ENSENSO measurement parameters	Refer to "8.2.1 ENSENSO measurement parameter settings ".

Table 8-2 Measurement parameters

No.	Parameter name	Unit	Value setting range	Default setting
1	Distance to Stand	mm	100 to 4000	300 Note 1
2	Depth of Measurement	mm	1 to 4000	45 Note 1
3	Exposure time	msec	0.1 to 10.0	1

Note 1: • Indicates the maximum working distance of the camera when calibration data is selected.
• Indicates the maximum measurement depth of the camera when calibration data is selected. Once calibration data is selected, the current setting values are retained in the parameters shown above.

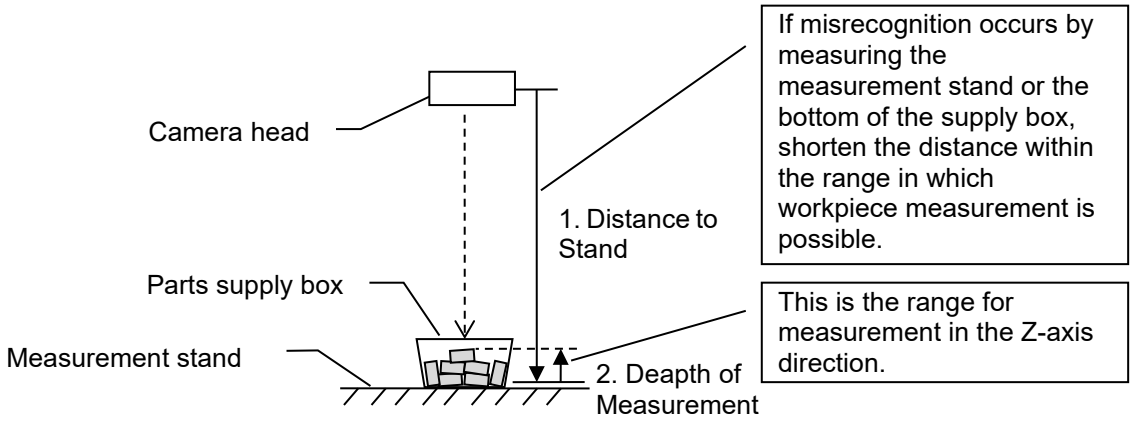


Fig. 8-3 Distance to measurement stand and measurement depth

◇◆◇Parts supply box◇◆◇

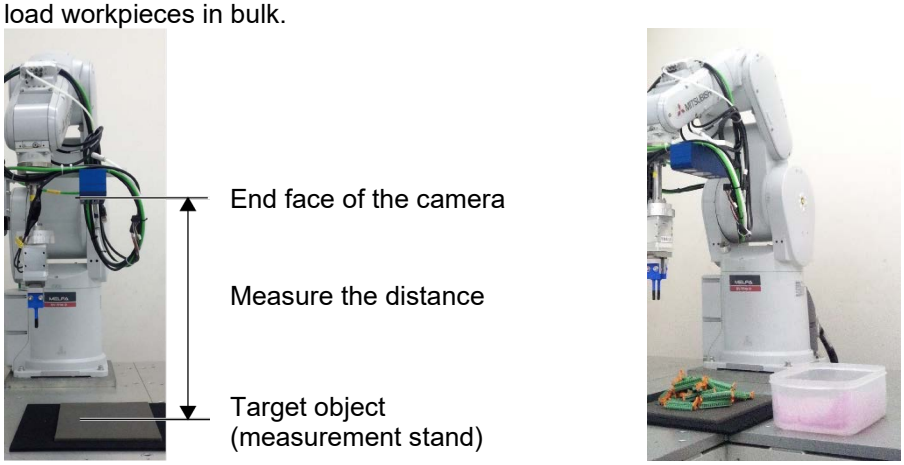
If a parts supply box has an uneven bottom as shown in the middle of the figure above, the robot may grasp the bottom surface. If a parts supply box has an inclined bottom as shown on the right of the figure above, the quantity of workpieces remaining in the box cannot be detected correctly. Ensure that the bottom of the parts supply box is flat and even.

■ Measurement method of the distance to the measurement stand

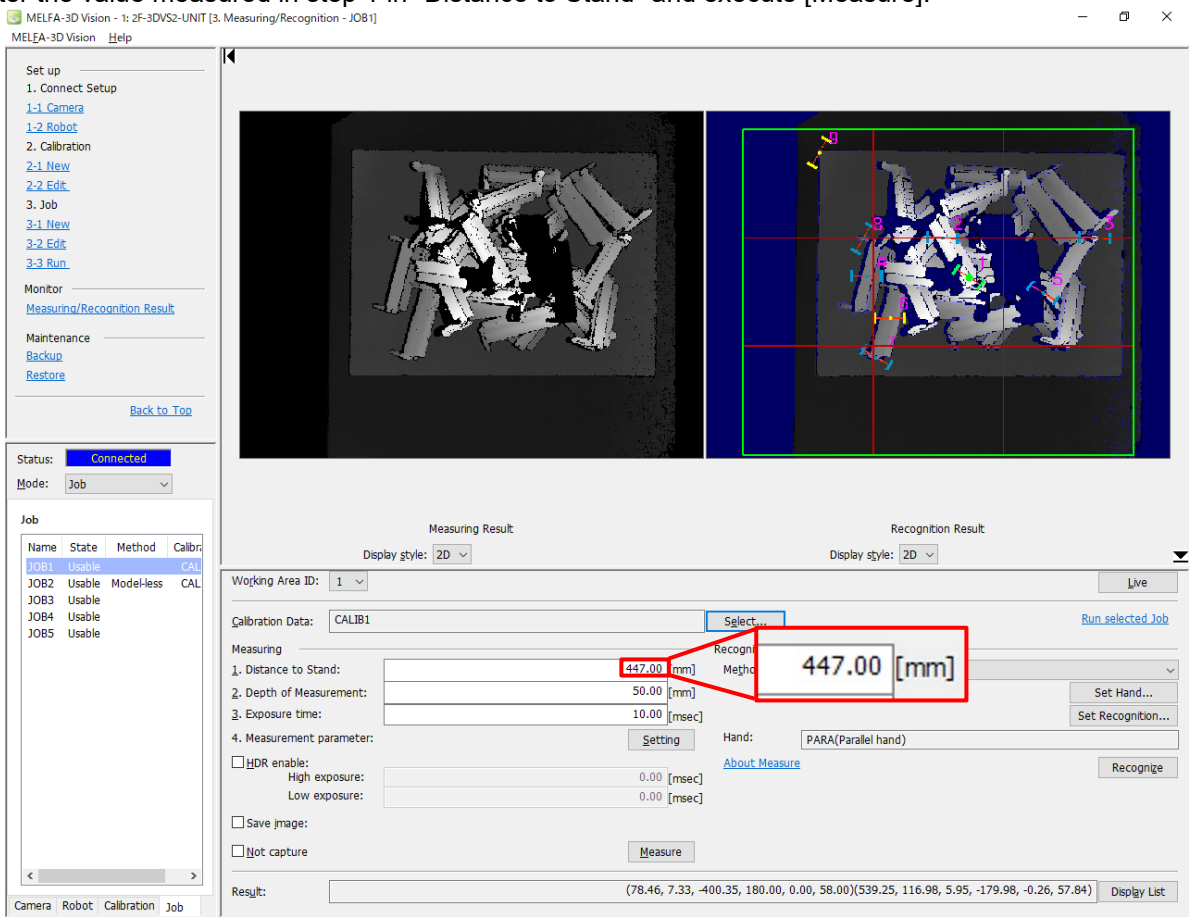
The origin (direction of height) in the camera coordinate system may be offset by a few millimeters from the end face of the camera. The amount of offset depends on the camera model, individual variations, and calibration results.

Perform the following procedure to fine-tune the value of "Distance to Stand".

1. Measure the distance from the end face of the camera to the target object with a ruler or other instrument, and load workpieces in bulk.



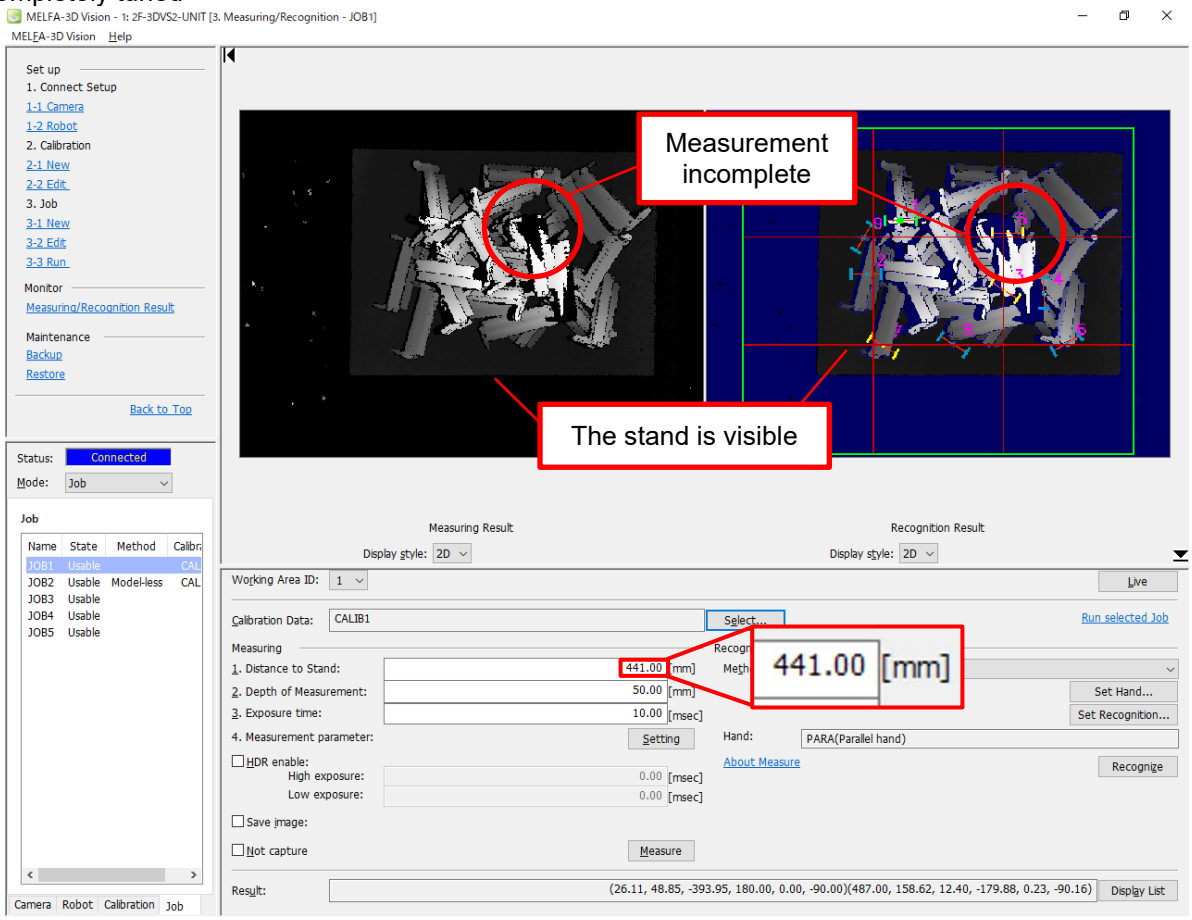
2. Enter the value measured in step 1 in "Distance to Stand" and execute [Measure].



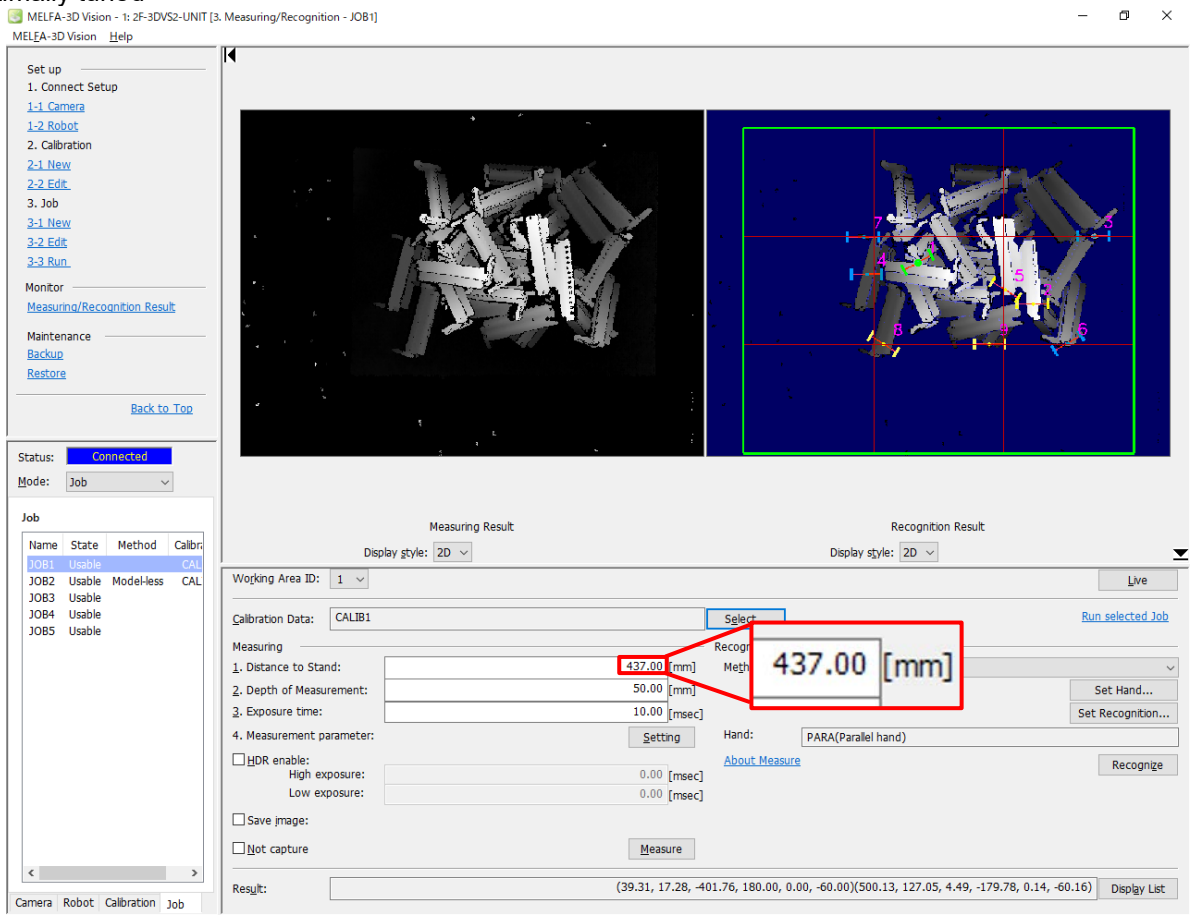
3. Fine-tune "Distance to Stand" and execute [Measure]. Repeat this operation until the stand is invisible and the

entire target object can be measured.

■ Incompletely tuned



■ Optimally tuned



4. The last value fine-tuned in step 3 is "Distance to Stand" which is used for actual measurement. In the above example, the value is 437.00.

■ HDR function
Pseudo dynamic range (brightness range of measurable workpieces) of imaging can be increased by performing measurement with [HDR enable] selected in the setting/operation field.
[Advantages]
By using the HDR function, white or dark clipping is less likely to occur in bright or dark workpieces. This function is effective where there are bright and dark workpieces.
[Precautions]
Imaging is performed according to the two exposure time settings, which requires longer measurement time.

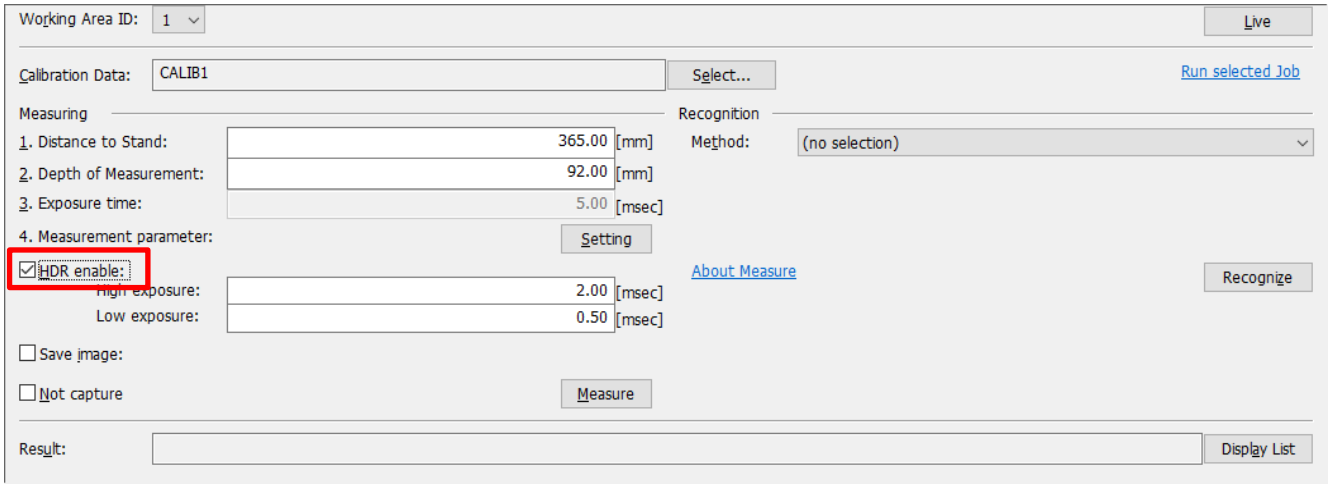


Fig.8-4 Measurement/recognition settings

To use the HDR function, select [HDR enable], set values in "High exposure" and "Low exposure", and press the [Measure] button to execute measurement. Enter values so that the value of "High exposure" is greater than that of "Low exposure".
When [HDR enable] is selected, imaging will be performed twice at a measurement according to the exposure time settings of [High exposure] and [Low exposure]. By synthesizing the images measured at two exposure times, a range image with few measurement omissions is output.

Table 8-3: Settings when [HDR enable] is selected

Item	Unit	Description	Initial value
High exposure	msec	Set an exposure time at high exposures. Set an exposure time at which dark workpieces can be measured.	2.0
Low exposure	msec	Set an exposure time at low exposures. Set an exposure time at which bright workpieces can be measured.	0.5

8.2.1. ENSENSO measurement parameter settings

In the setting/operation field, click [Setting] of "4. Measurement parameter" to open the Measurement Parameter Settings screen. Set the ENSENSO measurement parameters on this screen.

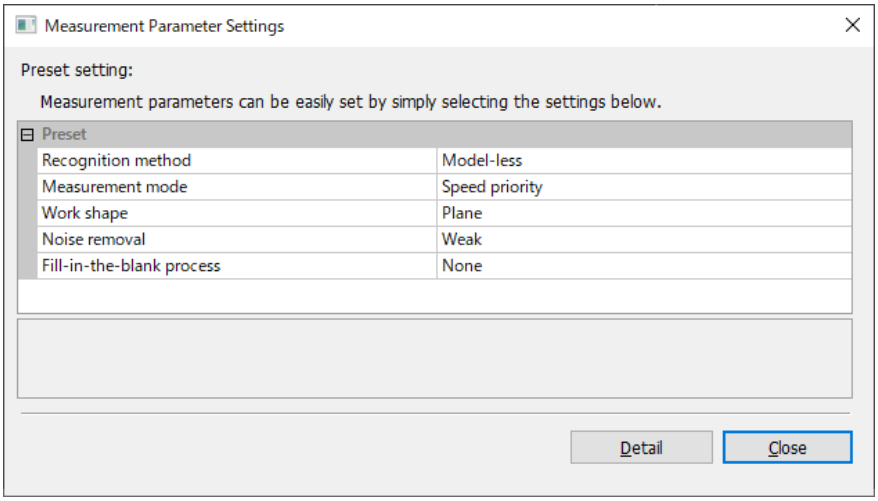


Fig.8-5 Measurement/recognition settings

Table 8-4: Information displayed on the Measurement Parameter Settings screen

Item	Description
Preset	List of preset items • Recognition method: Model-less/Model-matching • Measurement mode: Speed priority/Quality priority • Work shape: Plane/Curved surface • Noise removal: None/Weak/Moderate/Strong • Fill-in-the-blank process: None/Weak/Moderate/Strong
Preset explanation field	Explanation of preset
Detail button	All the measurement parameter items provided for ENSENSO cameras can be set.

In the preset list, select each preset value from the drop-down list according to the intended use.
Preset items are as follows.

Table 8-5: Measurement parameters preset

Item	Description
Recognition method	Set the parameter suitable for the recognition method. (The appropriate method may depend on the workpiece.) Selecting "Model-less" makes it possible to easily distinguish workpieces from each other, and reduce the noise above the measurement area. However, measurement accuracy tends to vary when measurement is performed on the surface steeply inclined to the camera. Selecting "Model-matching" produces an effect opposite to "Model-less".
Measurement mode	Selecting "Speed priority" performs measurement on one image. The measurement time is shorter, and the image quality is lower than those when "Quality priority" is selected. Selecting "Quality priority" performs measurement on multiple images. The measurement time is longer, and the image quality is higher than those when "Speed priority" is selected.
Work shape	Select the shape of the workpiece used for measurement. • Plane • Curved surface
Noise removal	Select the degree of removing noises generated in the measurement data. • None • Weak • Moderate • Strong
Fill-in-the-blank process	Select the degree of fill-in-the-blank processing using the surrounding measurement values if there are omissions of data measurement. • None • Weak • Moderate • Strong

The measurement parameters available for ENSENSO N35 / N36 can be adjusted directly from the [Detail] button. The following parameters can be adjusted in the [Detail] window. The measurement parameter list can be hidden by clicking [Hide].

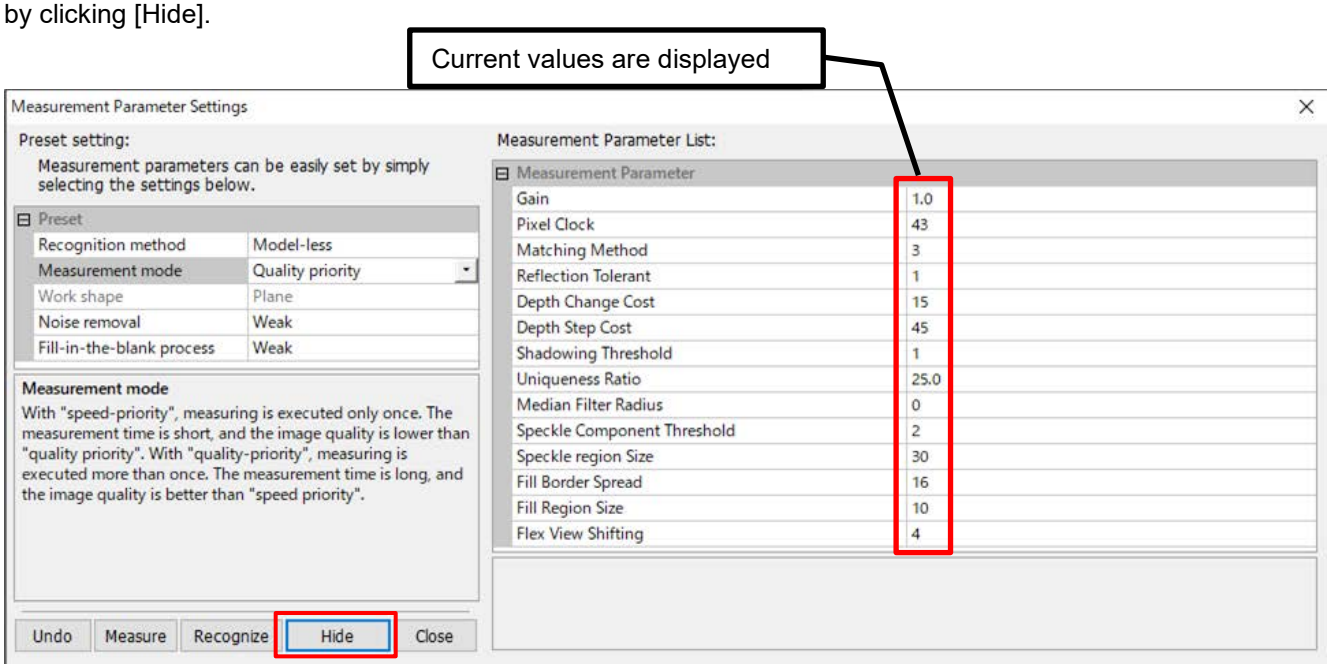


Fig.8-6 Measurement parameter detail settings window

Table 8-6: ENSENSO N35 / N36 measurement

Parameter name	Outline	Value setting range	Initial value
Gain Note 1	Set the signal amplification sensitivity.	1.0 -9.9	1.0
Pixel Clock Note 2	Set the pixel clock value. If the frame rate is low, change this value. If you change this value, you are recommended to check the exposure time setting again.	7 - 43	43
Matching Method	Set the stereo matching method. Note 3 0: Correlation-based stereo matching (Precision: high) 1: Semi-global matching with axis-aligned propagation (Precision: low) 2: Semi-global matching with diagonal propagation (Precision: low) 3: Semi-global matching with both axis-aligned and diagonal propagation (Precision: medium) To use correlation-based stereo matching, set Flex View Shifting to "5" or more.	0,1,2,3	3
Reflection Tolerant Note 4	Set the reflection resistance (0: weak; 1: strong). Set "1" when measuring highly reflective surfaces. Note that using strong reflection resistance will reduce Z-accuracy.	0,1	1
Depth Change Cost Note 4	As the value is greater, noises in the Z direction decrease more and slight change of brightness in images becomes more consistent. On the other hand, workpieces having a sharp shape irregularity in the Z direction such as a curved surface may become unmeasurable.	1 - 30	20
Depth Step Cost Note 4		2 - 127	60
Shadowing Threshold	Set the threshold of removing shadows. Removing shadows is easier as the value is higher, but the workpiece may be partly cut off. Setting "-1" disables this process.	-1,0,1,2	-1
Uniqueness Ratio	As the value is greater, the gap between workpieces becomes clearer, which enables separation between workpieces. On the other hand, measurement omissions tend to occur.	0.0 – 99.9	0.0
Median Filter Radius	As the value is greater, noises are removed more while retaining as much edge information as possible. If too great a value is set, the edge information will be lost.	0 - 10	0
Speckle Component Threshold	Set the threshold of minute measurement data to be cut off, for example, noises. As the value is greater, minute data are easier to be cut off, but workpieces may be partly cut off.	1 - 16	2
Speckle region Size	As the value is greater, minute measurement data except the data of the target workpiece can be cut off.	0 - 1000	100
Fill Border Spread	Set the threshold of whether or not to complement the measurement omissions. As the value is greater, it is easier to complement, but gaps may be complemented.	1 - 16	2
Fill Region Size	As the value is greater, complementing measurement omissions is performed more.	0 - 300	60
Flex View Shifting	Specify the number of images used for the ENSENSO camera's arithmetic averaging algorithm "Flex View". As the value is greater, slight change of brightness in images becomes more consistent, but measurement time will be longer.	1 - 16	1

Note 1:Even if a value larger than 4.0 is set for the N35 series, the value will be treated as 4.0.
Note 2:This parameter is not available for the N36. It is only enabled on the N35.
Note 3:For details, refer to "[Tree] → Cameras → 120001 (a stereo camera) → Parameters → DisparityMap → StereoMatching" in the ENSENSO SDK manual.
Note 4: This parameter is disabled if correlation-based stereo matching is set for the matching method.

Table 8-7: Information displayed on the Measurement Parameter Settings window

Item	Description
Measurement Parameter List	This is hidden by default. Press the [Detail] button to display the list.
Measurement parameter explanation field	Displays the explanation of the parameter.
[Hide] button	Hides the Measurement Parameter List.

■ Select the [Save image] or [Not capture] check box as required.
Select either of the following check boxes as required. Note that the settings of the selected check box are enabled only when the [Measure] button is clicked. Be aware that they are not enabled by job execution.

Table 8-8: Measurement options

Item	Description	Remarks
Save measurement data	When this check box is selected and the save destination is specified, the captured images and range images obtained during measurement are saved. Note 1	When this check box is selected, the save destination and [Browse] button are displayed. This may take some time depending on the use conditions.
Not capture	When this check box is selected, imaging is not performed. Range images are calculated using the images temporarily saved in the workspace and displayed in Result. Note 2	Use this option to obtain range images under different conditions using the same measured image.

Note 1:The table below lists the measurement data that will be saved.

File name	Description
CalibInfo.ini	Calibration data
MeasureInfo.ini	Distance to measurement stand, depth measurement, exposure time
CameraImage.jpg	Parallel image (calibrated camera image)
DepthImage.bmp	Range image (0 to 255)

Note 2: Selecting the [Not capture] check box and executing [Measure] will restore the data measured last. After the job is switched, data measured before the switching can be displayed again with this function.

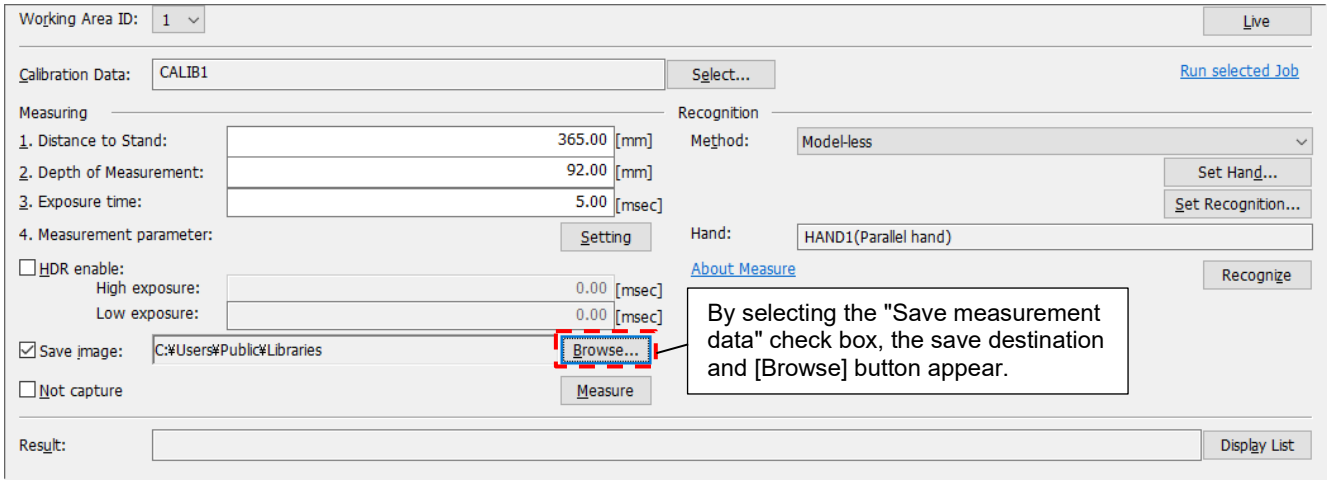


Fig.8-7 "Save image" check box

■ Checking the measurement results
Place a workpiece within the measurable area and click the [Measure] button to perform measurement. In 2D mode, a range image is displayed. The image appears whiter/darker as it is closer/further to/from the camera head. Check whether the range image appears as intended relative to the measured workpiece. Also, check that the workpiece is measured in three dimensions in 3D mode.

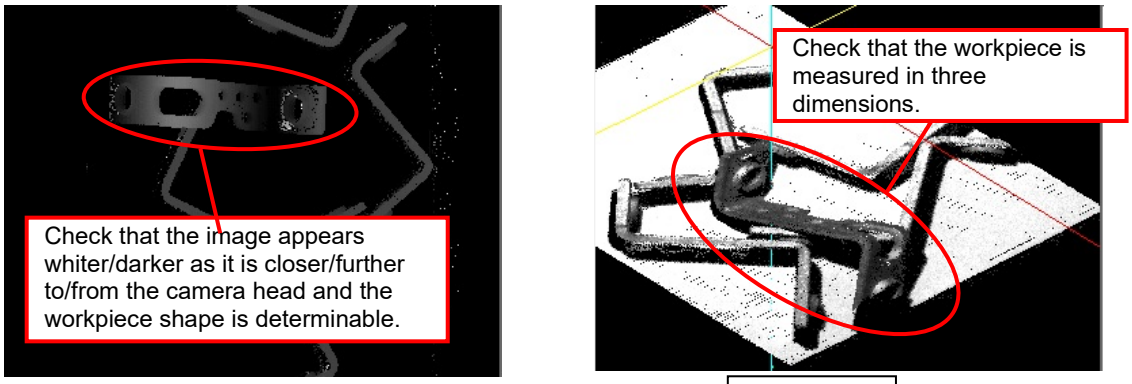


Fig.8-8 Checking the measurement results

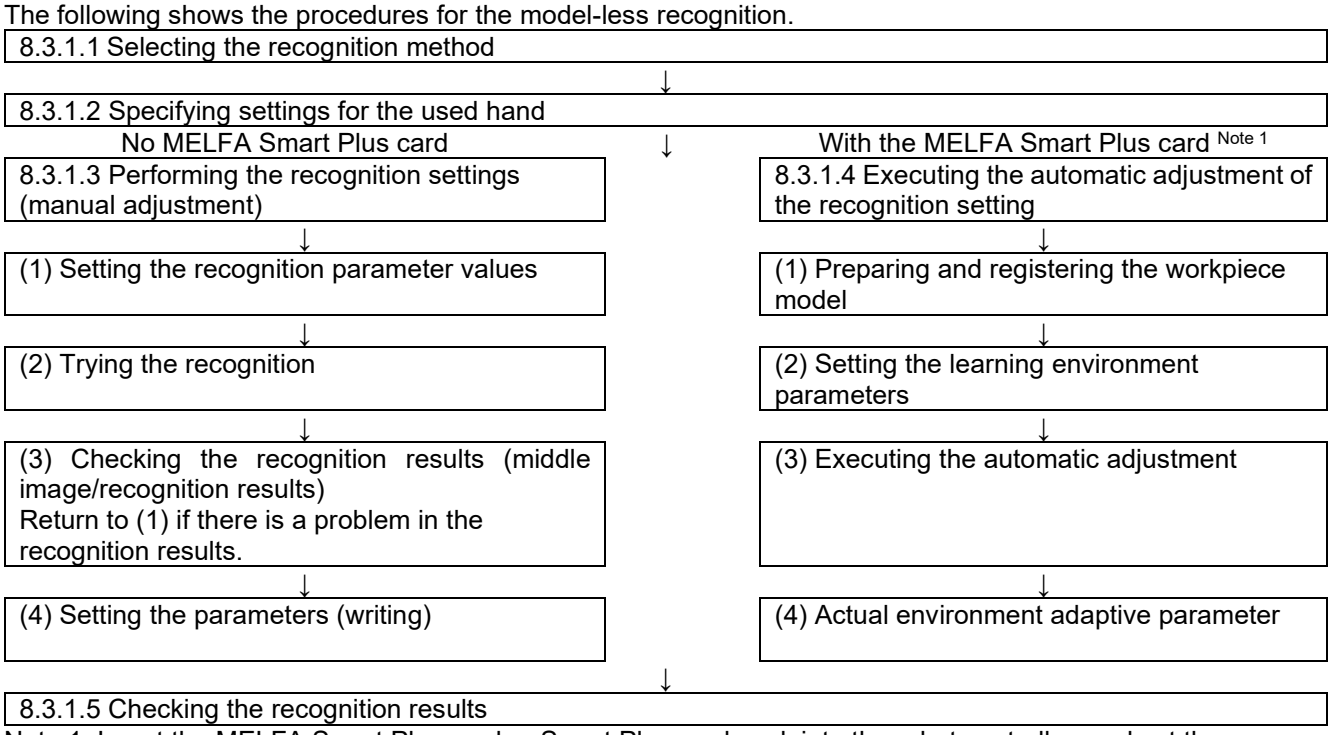
8.3. Recognition settings

There are two recognition methods, model-less recognition that does not require a workpiece 3D model, and model matching recognition that requires workpiece models to be registered.

8.3.1. Model-less recognition

Model-less recognition is a method used for bin picking, where hand information is used to detect gaps into which insertion is possible, or flat surfaces from which pickup is possible, for direct approach from directly above to the parts supply box. High speed bin picking can be achieved with a little operation amount. Since the approach is from directly above, only the X, Y, Z, and C position data components are valid.
For the direct approach to the parts supply box, it is necessary to consider the possibility of interference between the hand and the parts supply box. Therefore, design the hand by referring to "9.1Checking Interference with Surrounding Objects".

The following shows the procedures for the model-less recognition.



Note 1: Insert the MELFA Smart Plus card or Smart Plus card pack into the robot controller, and set the parameters and function codes. For information on how to configure the settings, refer to "When Using the MELFA-3D Vision Extended Function". For the corresponding model names, refer to "3.1 Product Check".
Recognition parameter automatic adjustment AI is available for the N35-804-16-IR, N35-806-16-IR, and N35-808-16-IR.
It is not available for the MELFA ASSISTA series.
When the robot controller software version is Ver.E4 or later, insertion of the MELFA Smart Plus card and the parameter settings are not necessary.
When the RT ToolBox3 version is Ver.2.70Y or later, the function code setting is not required.

8.3.1.1. Selecting the recognition method

Select "Model-less" from the drop-down menu.

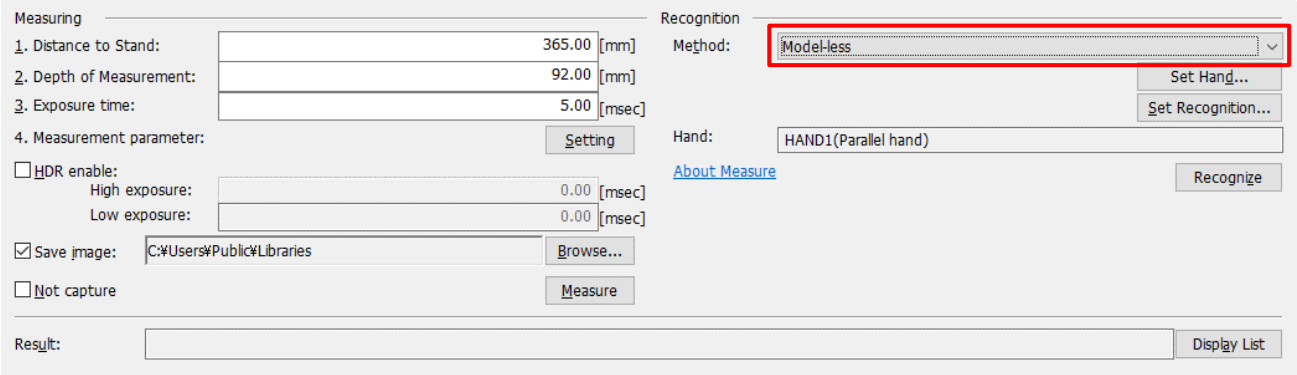


Fig.8-9 Selection of recognition methods (model-less recognition)

The table below describes the buttons that appear when the model-less matching is selected.

Table 8-9: Hand settings and recognition settings

Item name	Description	Remarks
Set Hand	A Hand settings screen appears. The Hand settings screen is used to set the hand types and the corresponding parameters.	
Set Recognition	Model-less recognition parameter settings appear. This screen is used to select the hand type to be used from those registered in the hand settings, and to set recognition parameters.	
Hand	The hand type to be used set in the hand settings is displayed.	

8.3.1.2. Specifying settings for the used hand

By clicking the [Set Hand] button, the Hand settings screen appears. Click the [Add] button at the Hand settings screen.
Enter the "Name [Note 1]", "Type", and "Parameter" for the hand being registered in the Hand addition screen.
"Parameter" can be edited by selecting the parameter name and clicking the [Change] button.
For information on hand types and the parameters that need to be set, refer to "Table 8-10: Hand types and parameters". Click the [Set] button to add the hand.
Note 1: Up to 32 single-byte alphanumeric characters

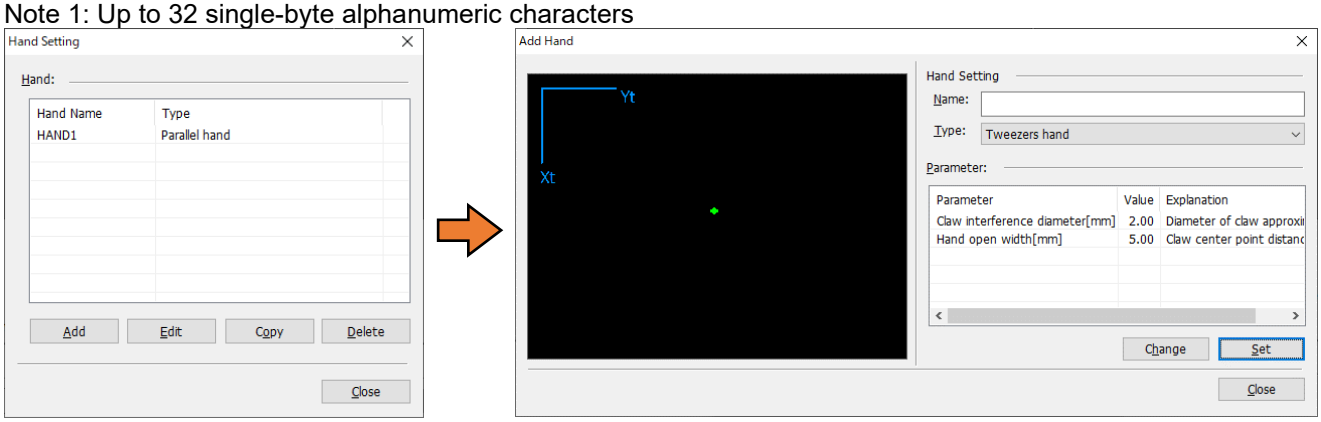


Fig.8-10 Hand settings

This system provides hands roughly classified to 3 types (Tweezers, Suction and Parallel). The following shows the characteristics of the hands and the parameters to define the hands.

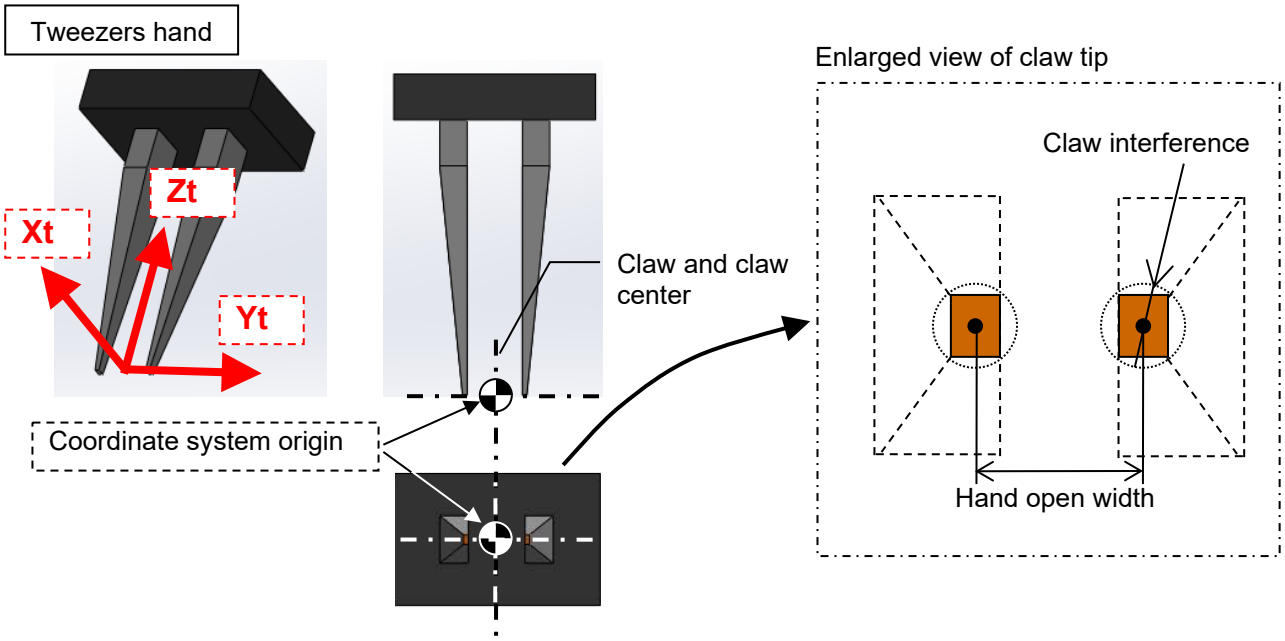


Fig.8-11 Hand coordinate system and hand parameters (Tweezers, Suction Hand)

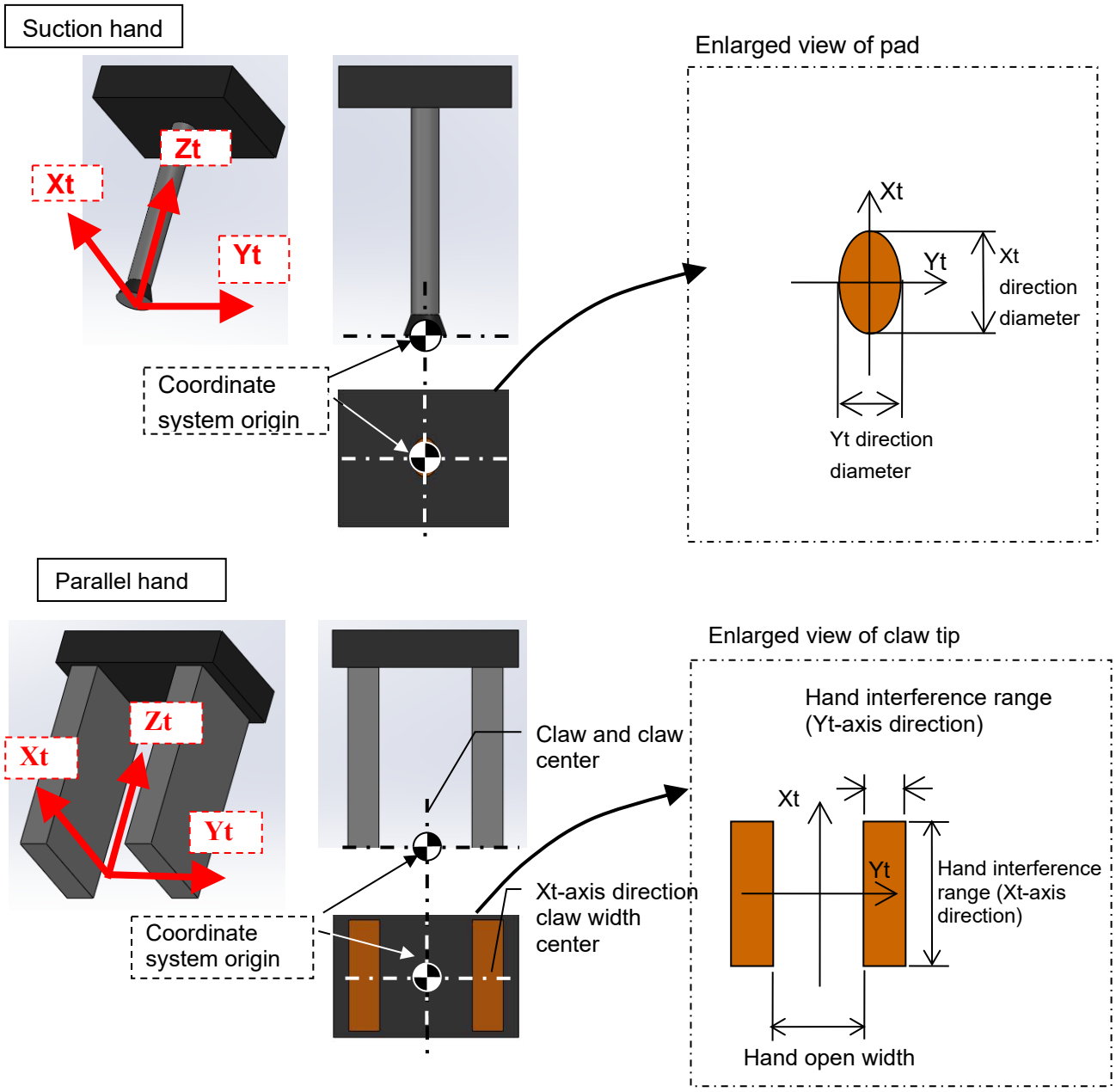
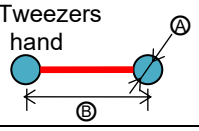
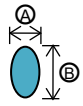
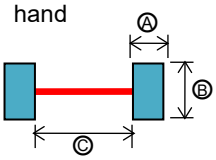
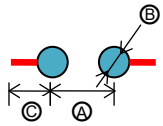
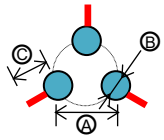
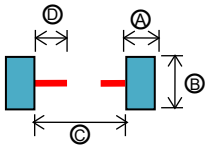
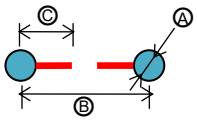
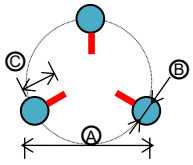
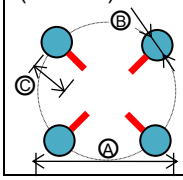


Fig.8-12 Hand coordinate system and hand parameters (Parallel hand)

Table 8-10: Hand types and parameters

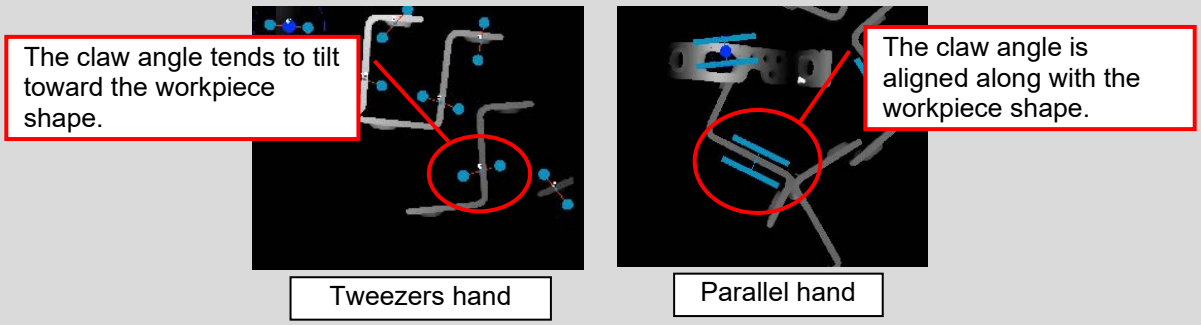
Hand type	Parameter	Unit	Description	Range	Default setting	Automatic adjustment*
Tweezers hand 	Claw interference diameter Ⓐ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand open width Ⓑ	mm	Claw center point distance when hand open	0.50 to 200.00	5.00	○
Suction hand 	Yt-axis direction diameter Ⓐ	mm	Yt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00	○
	Xt-axis direction diameter Ⓑ	mm	Xt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00	○
Parallel hand 	Claw interference diameter (Yt-axis direction) Ⓐ	mm	Yt-axis direction claw length in hand coordinate system	0.50 to 100.00	1.00	○
	Claw interference diameter (Xt-axis direction) Ⓑ	mm	Xt-axis direction claw length in hand coordinate system	0.50 to 100.00	1.50	○
	Hand open width Ⓒ	mm	Claw inner side distance when hand open	0.50 to 200.00	5.00	○

Hand type	Parameter	Unit	Description	Range	Default setting	Automatic adjustment*
 Tweezers hand gripping the inner (2 claws)	Hand close width Ⓐ	mm	Claw inner side distance when hand close	0.50 to 200.00	5.00	
	Claw interference diameter Ⓑ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand open width Ⓒ	mm	Claw moving length when hand close	0.50 to 100.00	5.00	
Tweezers hand gripping the inner (3 claws) 	Claws group interference diameter Ⓐ	mm	Diameter of interference area consists of claws when hand close	0.50 to 200.00	10.00	
	Claw interference diameter Ⓑ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand open width Ⓒ	mm	Claw moving length when hand close	0.50 to 100.00	5.00	
Parallel Hand (Limited stroke) 	Claw interference diameter (Yt-axis direction) Ⓐ	mm	Yt-axis direction claw length in hand coordinate system	0.50 to 100.00	1.00	
	Claw interference diameter (Xt-axis direction) Ⓑ	mm	Xt-axis direction claw length in hand coordinate system	0.50 to 100.00	1.50	
	Hand open width Ⓒ	mm	Claw inner side distance when hand open	0.50 to 200.00	5.00	○
	Hand close stroke Ⓓ	mm	Claw moving length when hand close	0.50 to 200.00	1.00	
Tweezers hand (Limited stroke) 	Claw interference diameter Ⓐ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand open width Ⓑ	mm	Claw inner side distance when hand open	0.50 to 200.00	5.00	○
	Hand close stroke Ⓒ	mm	Claw moving length when hand close	0.50 to 200.00	1.00	
Tweezers hand (3 claws) 	Claws group interference diameter Ⓐ	mm	Diameter of interference area consists of claws when hand open	0.50 to 200.00	10.00	○
	Claw interference diameter Ⓑ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand close stroke Ⓒ	mm	Claw moving length when hand close	0.50 to 200.00	1.00	
Tweezers hand (4 claws) 	Claws group interference diameter Ⓐ	mm	Diameter of interference area consists of claws when hand open	0.50 to 200.00	10.00	○
	Claw interference diameter Ⓑ	mm	Diameter of claw approximated with circle	0.50 to 50.00	2.00	
	Hand close stroke Ⓒ	mm	Claw moving length when hand close	0.50 to 200.00	1.00	

*The circle mark "○" indicates the automatic adjustment parameter.

◇◆◇Difference between tweezers hand and parallel hand◇◆◇

- The tweezers hand recognition speed is faster than that of the parallel hand.
- When gripping workpieces, the parallel hand is able to grip more steadily than the tweezers hand.
  * The claw angle of the parallel hand is aligned along with the workpiece shape. Therefore, the parallel hand does not tend to rotate when gripping a workpiece.



◇◆◇Registered hand settings◇◆◇

Hand settings created and registered here can also be used for other jobs.

8.3.1.3. Performing the recognition settings (manual adjustment)

This chapter explains how to adjust recognition settings manually.
To perform the recognition settings automatically, follow the instructions in "Executing the automatic adjustment of the recognition setting".

(1) Setting the recognition parameter values

Click the [Set Recognition] button to display model-less recognition parameter settings.
To change them, select the parameter to change from the list of recognition parameters, and then click [Change]. Enter a value at the displayed Parameter change screen and click the [Set] button.

Select "STEP2: Recognition range" next to "Step:", click the [Set Area] button, and drag the image to set a recognition range.The range specified here is reflected to the recognition range of the recognition parameter (Recognition range X start point, Recognition range X end point, Recognition range Y start point, Recognition range Y end point).

Select "STEP2: Recognition range" next to "Step:", click the [Set Floor Height] button and an area to be set as the floor on the image. The height of the selected area will be applied to the floor height of the recognition parameter.

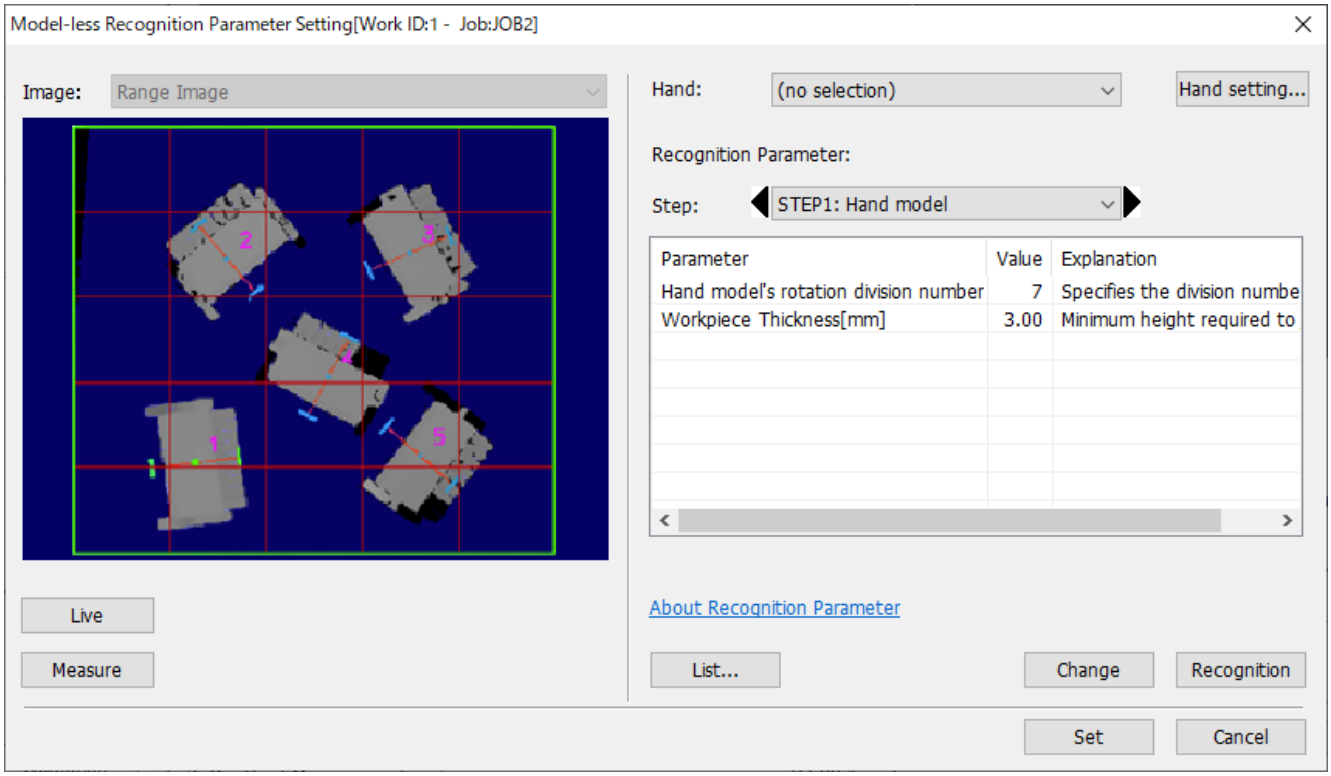


Fig.8-13 User settings for model-less recognition

Table 8-11: Recognition parameters

Parameter	Unit	Description		Range	Default setting	Automatic adjustment Note 1
STEP 1: Hand model						
Hand model's rotation division number Note 2 Note 3	-	Specifies the division number of 180 degrees. (Large: improved accuracy, small: increase in speed)		1 to 90	7	○
Workpiece Thickness	mm	Minimum height required to judge gaps as workpieces. The smaller the value, the greater the number of candidates, however, the possibility of misjudgment also increases.		0.10 to 100.00	3.00	○
STEP 2: Recognition range						
Bin floor height	mm	Distance that the floor is offset from the measurement surface. It is basically a fudge factor on the recognition side, saying don't start seriously looking for candidates unless they are x distance from the measurement surface		0 to 255	10	
Recognition range X start point Note 4	pixel	Distance from the left side of the screen to the X starting point. (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	N35	10 to 1260	100	
			N36	10 to 1596		
Recognition range X end point Note 4	pixel	Distance from the left side of the screen to the X end point. (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	N35	20 to 1270	1180	
			N36	20 to 1606	1516	
Recognition range Y start point Note 4	pixel	Distance from the top of the screen to the Y starting point. (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	N35	10 to 940	50	
			N36	10 to 1192		
Recognition range Y end point Note 4	pixel	Distance from the top of the screen to the Y end point. (20-950) default: 950 (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	N35	20 to 950	950	
			N36	20 to 1202	1202	
Number of Horizontal Recognition Area Divisions (X direction)	-	Horizontal recognition area is divided into N number of equally sized segments (X direction) Small: Fast detection, Few candidates. Big: Slow detection, Many candidates.		2 to 7	3	
Number of Vertical Recognition Area Divisions (Y direction)	-	Recognition range is divided by the specified number of divisions. (Y direction) Small: Fast detection, Few candidates. Big: Slow detection, Many candidates.		2 to 7	3	
Recognition range margin Note 5	mm	Set the margin of the recognition range.		-50 to 100	0	
Height of box Note 5	mm	Set the height of the box.		0.00 to 300.00	0.00	

Parameter	Unit	Description		Range	Default setting	Automatic adjustment Note 1
Boundary output Note 6	%	Disabled: the recognition result within the recognition range is output. Enabled: the workpiece that exists at the boundary of the recognition range is output as recognition result. However, part of the hand may out of the recognition range, so please be careful with interference with surroundings.		0: Disabled 1: Enabled	0	
STEP 3: Outline extraction						
Edge Identification sensitivity	-	Threshold of edge strength for segmentation.		1 to 1000	30	○
Circle Detection: Enable/Disable	-	Disabled: Normal setting to avoid the fragmentation of segments. Ex. Non-circular work, thin ring. Enabled: Activation of cutting out segments for easier recognition of the circular work with specified diameter.		0: Disabled 1: Enabled	0	
Circle Detection: Diameter	mm	Diameter of the circle for detection		10.00 to 150.00	30.00	
STEP 4: Segment size						
Minimum area per part	mm^2	The minimum area inside of viewing the workpiece from various angles. By increasing the value, candidates for workpiece are narrowed down. However, if the value is set too large, the workpiece may not be detected.		1 to 33600	5	○
Maximum area per part Note 7	mm^2	The maximum area insideof viewing the workpiece from various angles. By decreasing the value, candidates for workpiece are narrowed down. However, if the value is set too small, the workpiece may not be detected.		1 to 2625000	168000	○
Smooth strength	-	The greater the value, the more noise is reduced.		-1: Original 0: No filter 1 to 4	4	○
STEP 5: Recognition processing						
Full search mode: Enable/Disable	-	0 - Disable: Search candidates at center of the segment. 1 - Enable: Search candidates at center of the segment and full region. This setting needs much more time, but enlarges the number of detection points.		0: Disabled 1: Enabled	1	○
Image Scale factor Note 8	-	After the image is reduced to 1/n, it is processed. A low value increases accuracy but processes slower, and a high value has decreased accuracy with faster processing.		1 to 8	2	
Main axis feature mode Note 9	-	Swith the main axis feature mode (length feature, angle estimate)		0: Disable 1: Length 2: Angle 3: Length + Angle	0	○
Minimum main axis length Note 9	mm	Check that the length of the main axis is greater than or equal to this threshold. The length of the main axis is calculated with		1 to 250	10	○

Parameter	Unit	Description		Range	Default setting	Automatic adjustment Note 1
		ellipse (circumcircle) fitting				
Maximum main axis length Note 9	mm	Check that the length of the main axis is less than or equal to this threshold. The length of the main axis is calculated with ellipse (circumcircle) fitting		10 to 1000	100	○
Minimum main axis ratio Note 9	%	Check that the ratio of minor axis to major axis is greater than or equal to this threshold. The major axis and minor axis are calculated with ellipse (circumcircle) fitting		0 to 100	0	○
Maximum main axis ratio Note 9	%	Check that the ratio of minor axis to major axis is less than or equal to this threshold. The major axis and minor axis are calculated with ellipse (circumcircle) fitting		0 to 100	100	○
Posture output Note 10	-	Change the output mode for the posture component. When you output component B, validate the main shaft characteristics (direction estimate) mode. Select RH type when the RV model hanging from the ceiling is used. 0: Camera coordinates (component C) 1: Robot coordinates (component C, RV type) 2: Robot coordinates (components B and C, RV type) 3: Robot coordinates (component C, RH type) 4: Robot coordinates (components B and C, RH type) 5: Robot coordinates (component A, B, and C, RV type) 6: Robot coordinates (components A, B and C, RH type) 0: Posture in the camera coordinates system is output. 1 to 6: Posture in the robot coordinates system is output. Select 2, 4, 5, or 6 when the grip force for the normal direction of the object is expected. * Regarding the camera coordinates system, refer to 2.4.4 Camera coordinate system. * The robot coordinates system is the base coordinates system.		0 to 6	1	
Recognized candidates output	-	Sort the order of the recognized candidates.		1: Graspabiity (descendling order) 2: Average Height (descending order) 21: Grasperbility x Average Heigh (descending order)	21	

Parameter	Unit	Description		Range	Default setting	Automatic adjustment Note 1
Calculation processing of the residual percentage against the full measurement volume Note 11 Note 12	-	Calculate the residual percentage against the full measurement volume by enabling this function. Remain 1: Workpiece residual rate calculated based on the height information (component Z) Remain 2: Workpiece residual rate calculated based on the recognition range information (component XY)		0: Disabled 1: Enabled	0	

Note 1: The circle mark "○" indicates the automatic adjustment parameter.

Note 2: Hand model rotation angle resolution

Model-less recognition involves searching for gaps into which hand model claw can be inserted and flat surfaces to which suction pads can be attached, and returning this as the recognition result. When doing so, the search is performed while rotating the hand model, and therefore the resolution is specified.

Note 3: Hand model rotation angle resolution
By entering a small value, the recognition time decreases, however, the accuracy of the hand model rotation angle drops, and the number of candidate grip positions decreases. By entering a large value, the recognition time increases, however, the accuracy of the hand model rotation angle improves, and the number of candidate grip positions increases. If using a tweezers hand or parallel hand, if the rotation angle accuracy drops, there is a possibility that the workpiece may rotate when gripped. When using a suction hand with a pad of the shape other than a perfect circle such as an ellipse, air may leak.

Note 4: As the recognition range widens, the recognition time gets longer. Upper Left: Origin, Right direction: +X, Down direction: +Y.

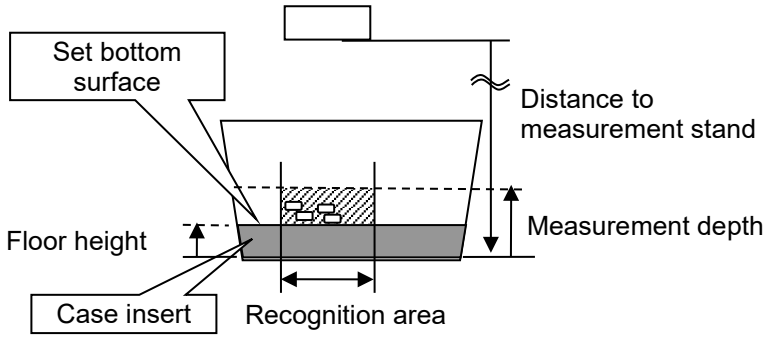


Fig.8-14 Definition of the bin floor height and the recognition domain

Note 5: Margin in the recognition area and box height

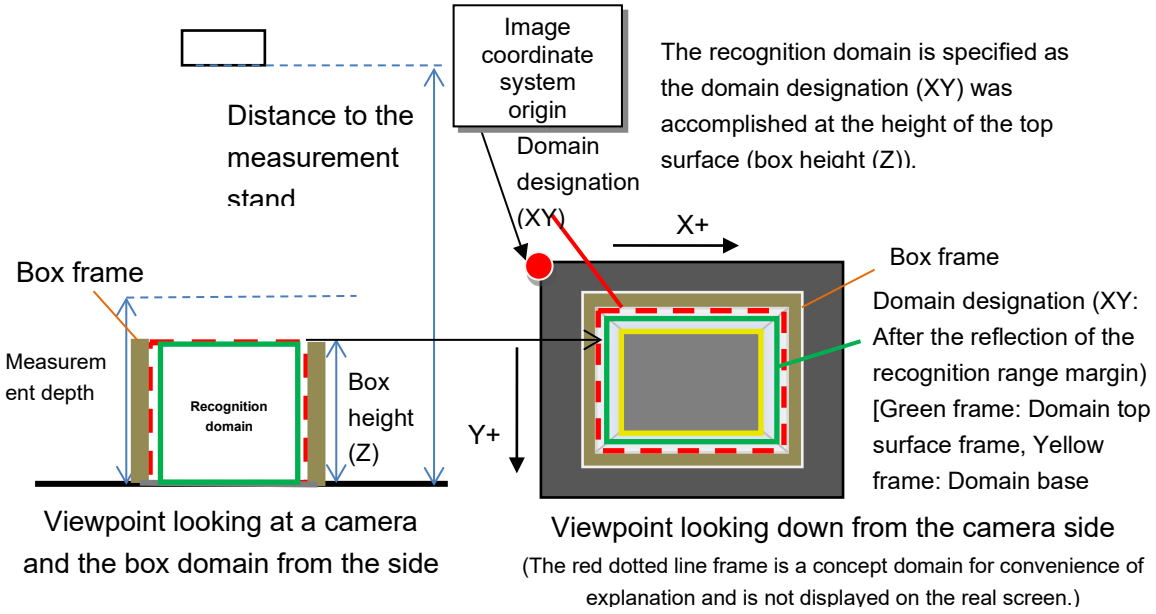


Fig.8-15 Explanatory drawing for the recognition domain (recognition range margin, height of box)

Note 6: Boundary output

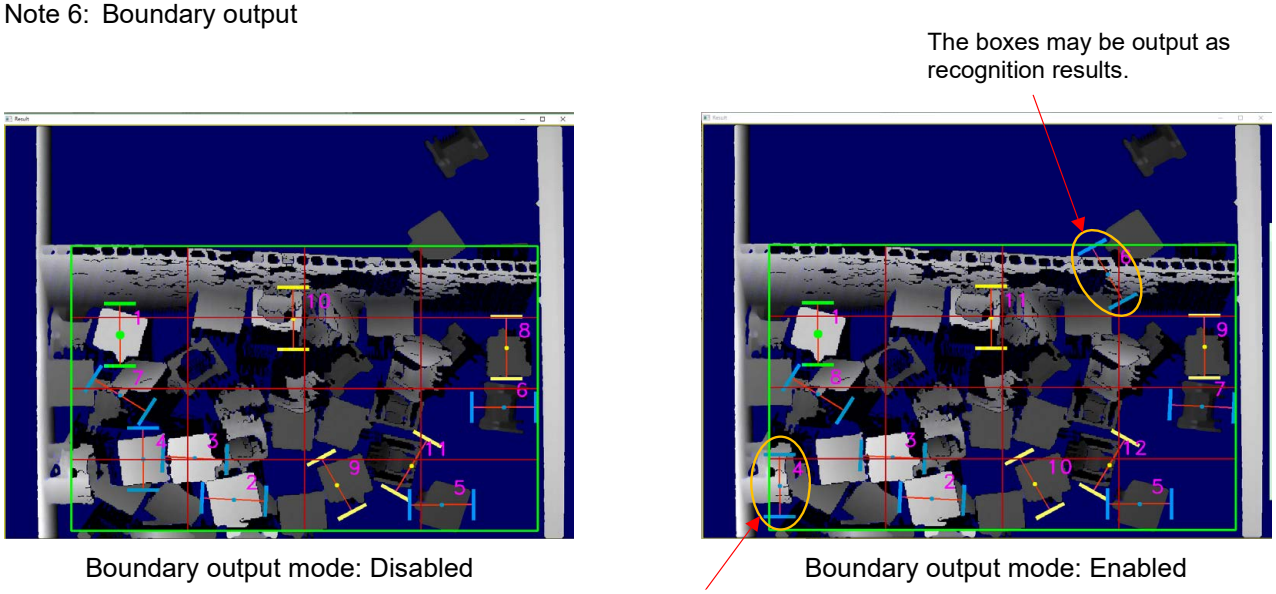


Fig.8-16 Differences between the boundary output mode enabled and disabled

Note 7: Maximum area in the workpiece appearance

Example: When the workpiece shape is cube
The workpiece appearance in the direction shown in the figure below is the maximum.

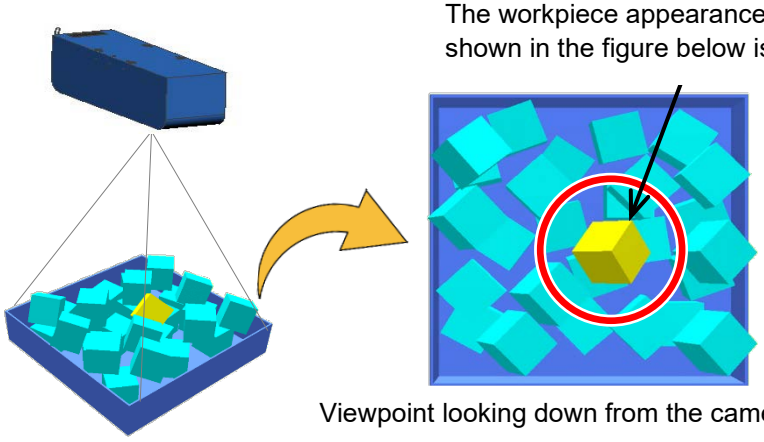


Fig.8-17 Example of the maximum area in the workpiece appearance

Note 8: By entering a small value, the recognition time increases, however, the recognition accuracy improves.
By entering a large value, the recognition time decreases, however, the recognition accuracy drops.

Note 9: Features of the main axis

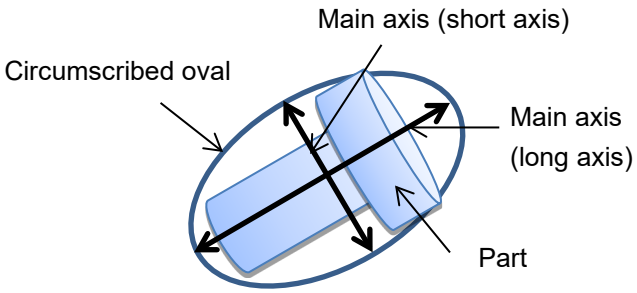


Fig.8-18 Definition for the main axis feature mode

Note 10: Addition of the posture output mode

By setting the posture output mode, the workpieces can be gripped according to their tilt.
The following shows the posture output image. The postures of the component C, BC, and ABC are shown from the left.
To grip the bar-shaped workpieces according to their tilt, use mode "2" or "4" in which the component BC posture can be output.
To grip the bar-shaped workpieces according to their workpiece tilt, use mode "5" or "6" in which the component ABC posture can be output.

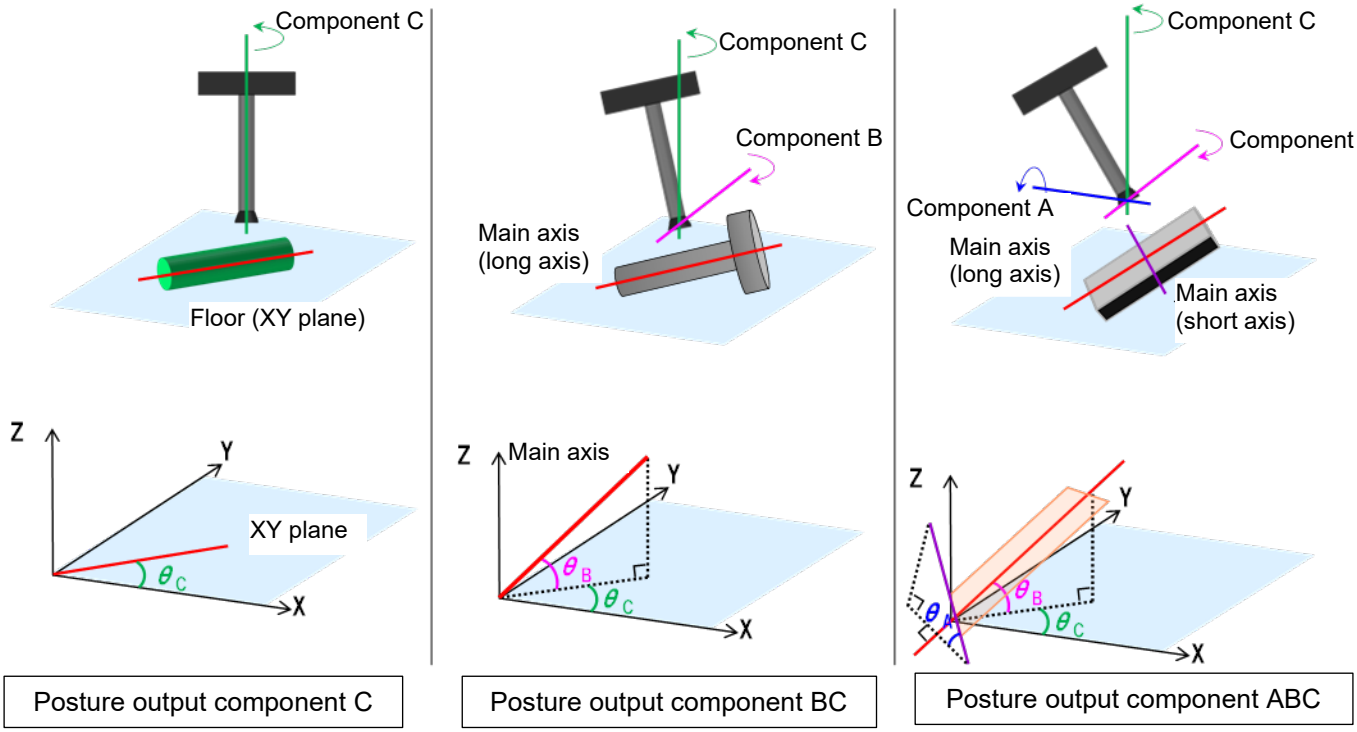


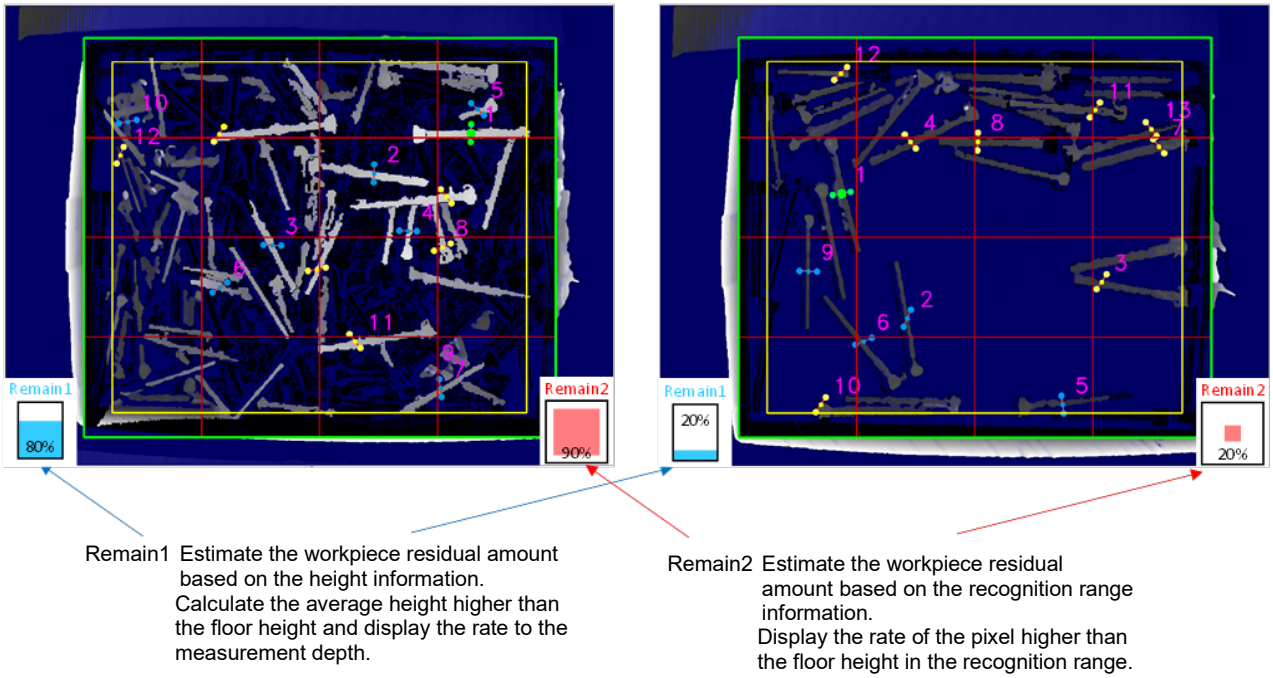
Fig.8-19 Posture output image

Note 11: If the hand claw or suction pad interferes with the measurement stand or bottom of the parts supply box because of misrecognition resulting from measurement data for the measurement stand or bottom of the parts supply box, or due to noise, interference can be avoided by entering a large value. However, if the workpiece residual amount becomes lower than the specified value, recognition is not performed even if there are workpieces remaining, and therefore the number of workpieces that can be taken out drops.

Note 12: Workpiece residual amount display

When the workpiece amount is large

When the workpiece amount is small



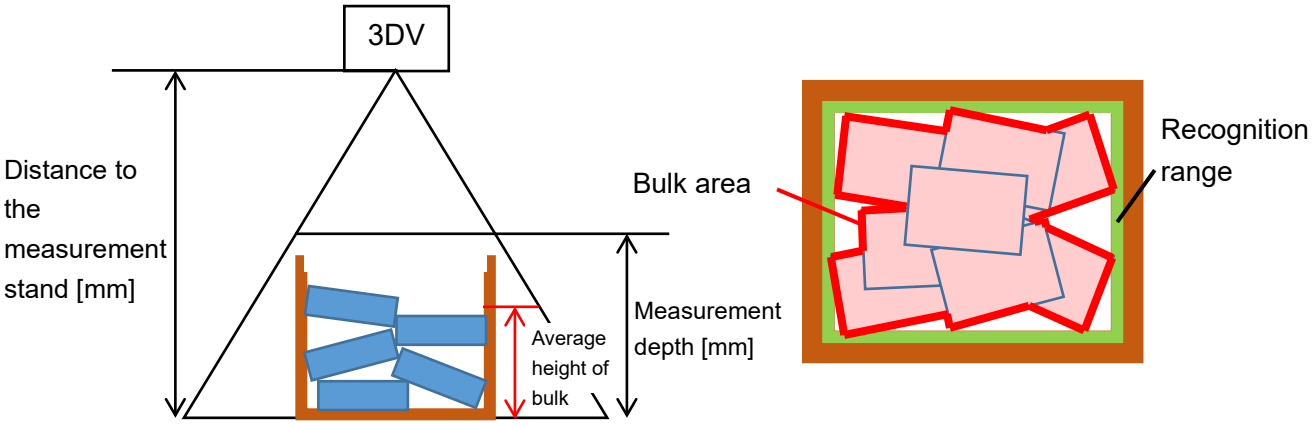
Remain1 Estimate the workpiece residual amount based on the height information.
Calculate the average height higher than the floor height and display the rate to the measurement depth.

Remain2 Estimate the workpiece residual amount based on the recognition range information.
Display the rate of the pixel higher than the floor height in the recognition range.

Fig.8-20 Display example of the workpiece residual amount

For the workpiece residual amount, the following two viewpoints are considered and quantified.
・Remain1: Calculate the workpiece residual amount based on the height information (component Z). (0 to 100%)
・Remain2: Calculate the workpiece residual amount based on the recognition range information (component XY). (0 to 100%)

The following shows the workpiece residual rate definition (calculation method).



Remain1 calculation method
(The rate of the average height to the measurement depth)

Remain2 calculation method
(The rate of the bulk area to the recognition

Fig.8-21 Workpiece residual rate definition (calculation method)

The workpiece residual amount (condition) in the box can be estimated by using the values of Remain1 and Remain2. The following shows the relationship between the two values.

Table 8-12: Relationship between Remain1 and Remain2

		Remain1 (Workpiece residual rate calculated from the height information)	
		High	Low
Remain2 (Workpiece residual rate calculated from the recognition range information)	High	There are a lot of workpieces in the box.	The workpieces are stacked in bulk.
	Low	The workpieces are inclined to one side.	There are a few workpieces in the box.

The values of Remain1 and Remain2 are stored in the status variable (M_V3Rmn1, M_V3Rmn2) of the robot.
For details of the status variable, refer to "12.2 MELFA-3D Vision Related Status Variables".

(2) Trying the recognition

By clicking the [Try Recognition] button, recognition is performed based on the set conditions and the result is displayed in the image on the left.

(3) Checking the recognition results (middle image/recognition results)

In order to confirm the process until the recognition results (each STEP of the recognition parameters), the displayed images (images during the recognition process) can be changed by selecting the type of image among the images (I): pull-down. The effect of each recognition parameter can be confirmed by the image at each step.

Fig.8-22 illustrates an example of an indication image.

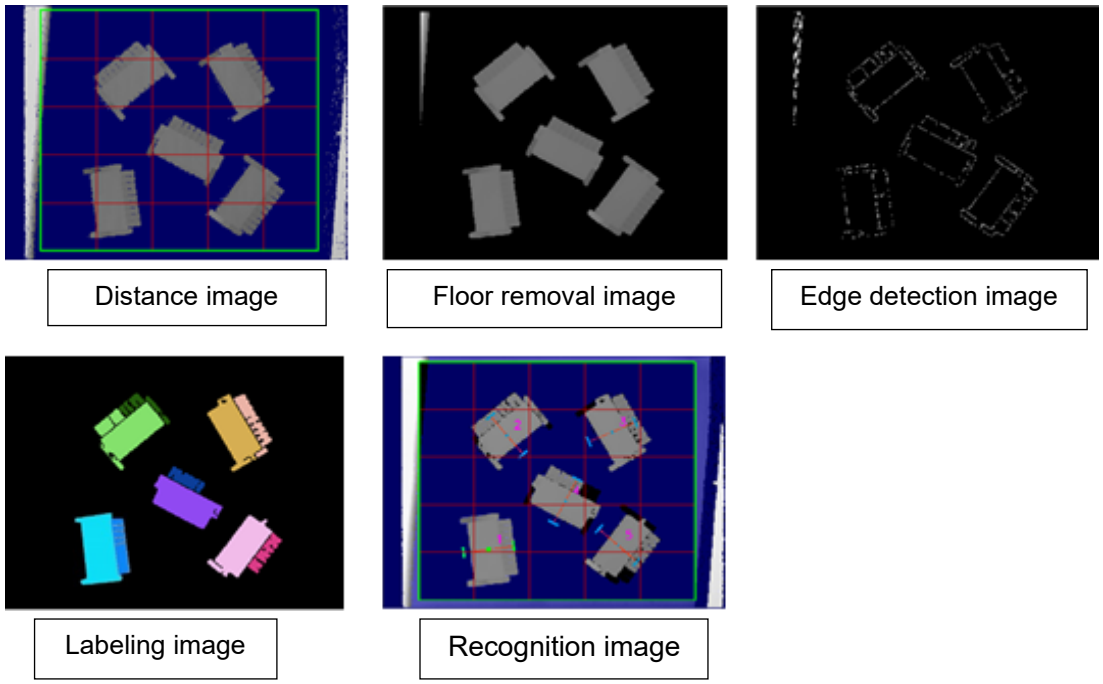


Fig.8-22 Types of display images

(4) Setting the parameters (writing)

If there are no problems with the recognition time or recognition result, click the [Set] button and then close the Model-less recognition parameter settings screen.

8.3.1.4. Executing the automatic adjustment of the recognition setting

The following shows how to adjust the recognition setting automatically.
To manually perform the recognition setting, follow " 8.3.1.3 Performing the recognition settings (manual adjustment) ".
The following shows the parameters that are adjusted automatically.

Table 8-13: Automatic adjusted recognition parameter

Parameter	Unit	Description	Range	Default setting
Hand model's rotation division number Note 1 Note 2	-	Specifies the division number of 180 degrees. (Large: improved accuracy, small: increase in speed)	1 to 90	7
Workpiece Thickness	mm	Minimum height required to judge gaps as workpieces. The smaller the value, the greater the number of candidates, however, the possibility of misjudgment also increases.	0.10 to 100.00	3.00
Edge Identification sensitivity	-	Threshold of edge strength for segmentation.	1 to 1000	30
Minimum area per part	mm^2	Minimum amount of pixels that must be grouped together to constitute a part. Aussumtion is the size of the part is converted to pixels by the following formula.	1 to 33600	100
Maximum area per part Note 3	mm^2	Maximum amount of pixels that when grouped together constitute a part. Aussumtion is the size of the part is converted to pixels by the following formula.	1 to 168000	168000
Smooth strength	-	The greater the value, the more noise is reduced.	-1: Original 0: No filter 1 to 4	4
Full search mode: Enable/Disable	-	Disabled: Normal setting to avoid the fragmentation of segments. Ex. Non-circular work, thin ring. Enabled: Activation of cutting out segments for easier recognition of the circular work with specified diameter.	0: Disabled 1: Enabled	1
Main axis feature mode Note 4	-	Swith the main axis feature mode (length feature, angle estimate)	0: Disable 1: Length 2: Angle 3: Length + Angle	0
Minimum main axis length Note 4	mm	Check that the length of the main axis is greater than or equal to this threshold. The length of the main axis is calculated with ellipse (circumcircle) fitting	1 to250	10
Maximum main axis length Note 4	mm	Check that the length of the main axis is less than or equal to this threshold. The length of the main axis is calculated with ellipse (circumcircle) fitting	10 to 1000	100
Minimum main axis ratio Note 4	%	Check that the ratio of minor axis to major axis is greater than or equal to this threshold. The major axis and minor axis are calculated with ellipse (circumcircle) fitting	0 to 100	0
Maximum main axis ratio Note 4	%	Check that the ratio of minor axis to major axis is less than or equal to this threshold. The major axis and minor axis are calculated with ellipse (circumcircle) fitting	0 to 100	100

Note 1: Hand model rotation angle resolution
Model-less recognition involves searching for gaps into which hand model claw can be inserted and flat surfaces to which suction pads can be attached, and returning this as the recognition result. When doing

so, the search is performed while rotating the hand model, and therefore the resolution is specified.

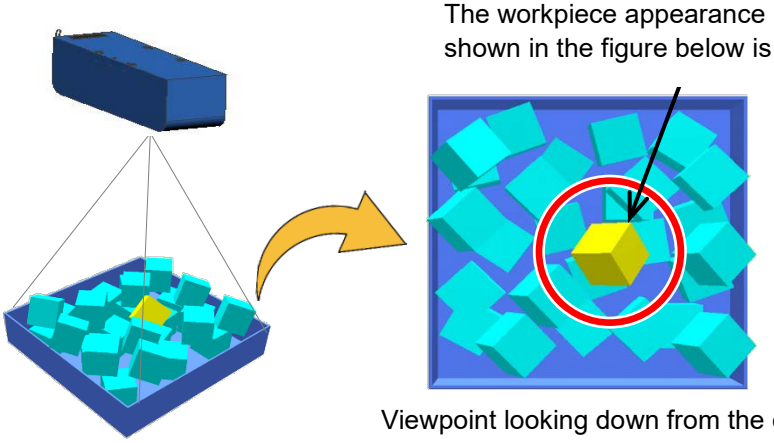
Note 2: Hand model rotation angle resolution

By entering a small value, the recognition time decreases, however, the accuracy of the hand model rotation angle drops, and the number of candidate grip positions decreases. By entering a large value, the recognition time increases, however, the accuracy of the hand model rotation angle improves, and the number of candidate grip positions increases. If using a tweezers hand or parallel hand, if the rotation angle accuracy drops, there is a possibility that the workpiece may rotate when gripped. When using a suction hand with a pad of the shape other than a perfect circle such as an ellipse, air may leak.

Note 3 Maximum area in the workpiece appearance

Example) When the workpiece shape is cube

The workpiece appearance in the direction shown in the figure below is the maximum.



Viewpoint looking down from the camera side

Fig.8-23 Example of the maximum area in the workpiece appearance

Note 4: Features of the main axis

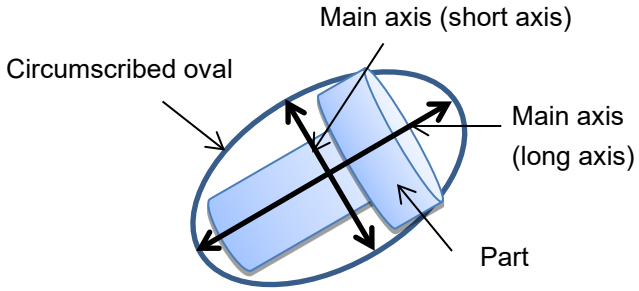


Fig.8-24 Definition for the main axis feature mode

Start the automatic adjustment from the [Model-less Recognition Parameter Setting] screen.

1. Click the [Set Recognition] button in the job edit screen to display the Model-less Recognition Parameter Setting screen.
2. Press the [Automatic Setting] button. (This button is disabled if an unsupported model is connected.)
3. The following caution window appears. Click [OK] to display the Automatic adjustment screen.

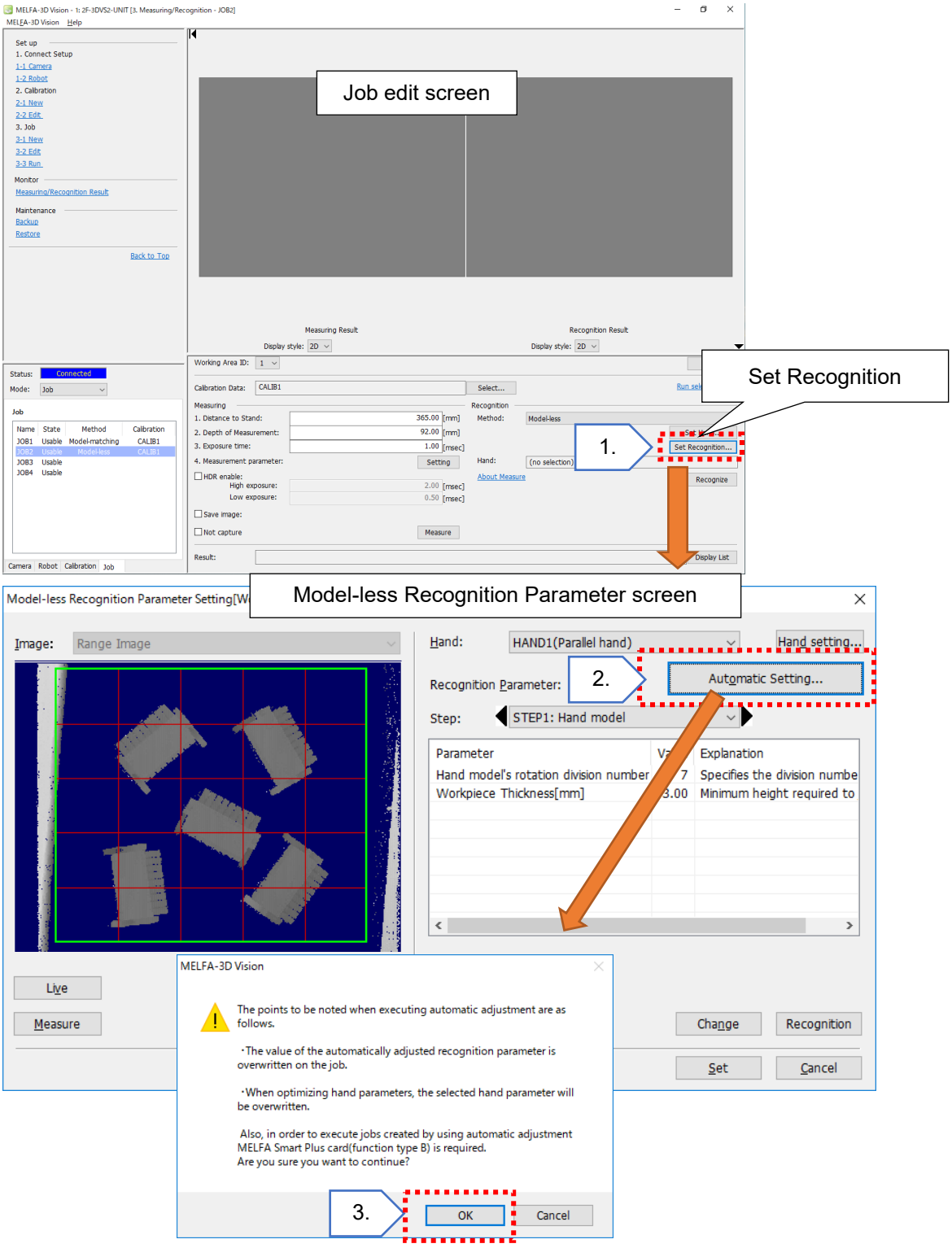


Fig.8-25 Model-less Recognition Parameter screen

(1) Preparing and registering the workpiece model

First, register the workpiece model for which the automatic adjustment is executed.
(If you do not have a workpiece model, you can create a workpiece model file using the layout tool of RT ToolBox3.)

1. Click the [Select] button and select the corresponding workpiece model. The applicable model type is STL, OBJ, and PLY (except for the models that including RGB channel).
2. The image of the selected workpiece model is displayed in the screen.

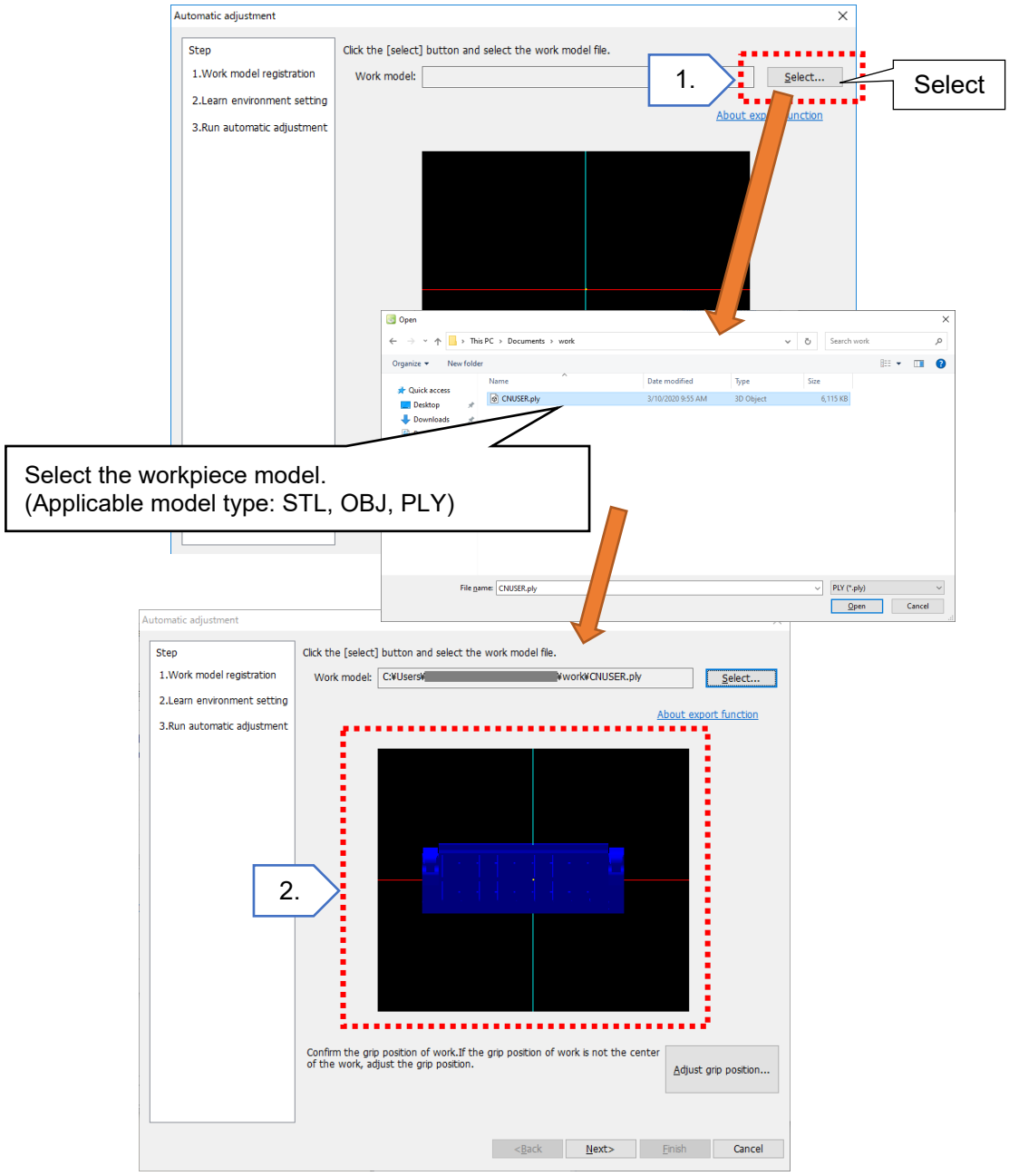
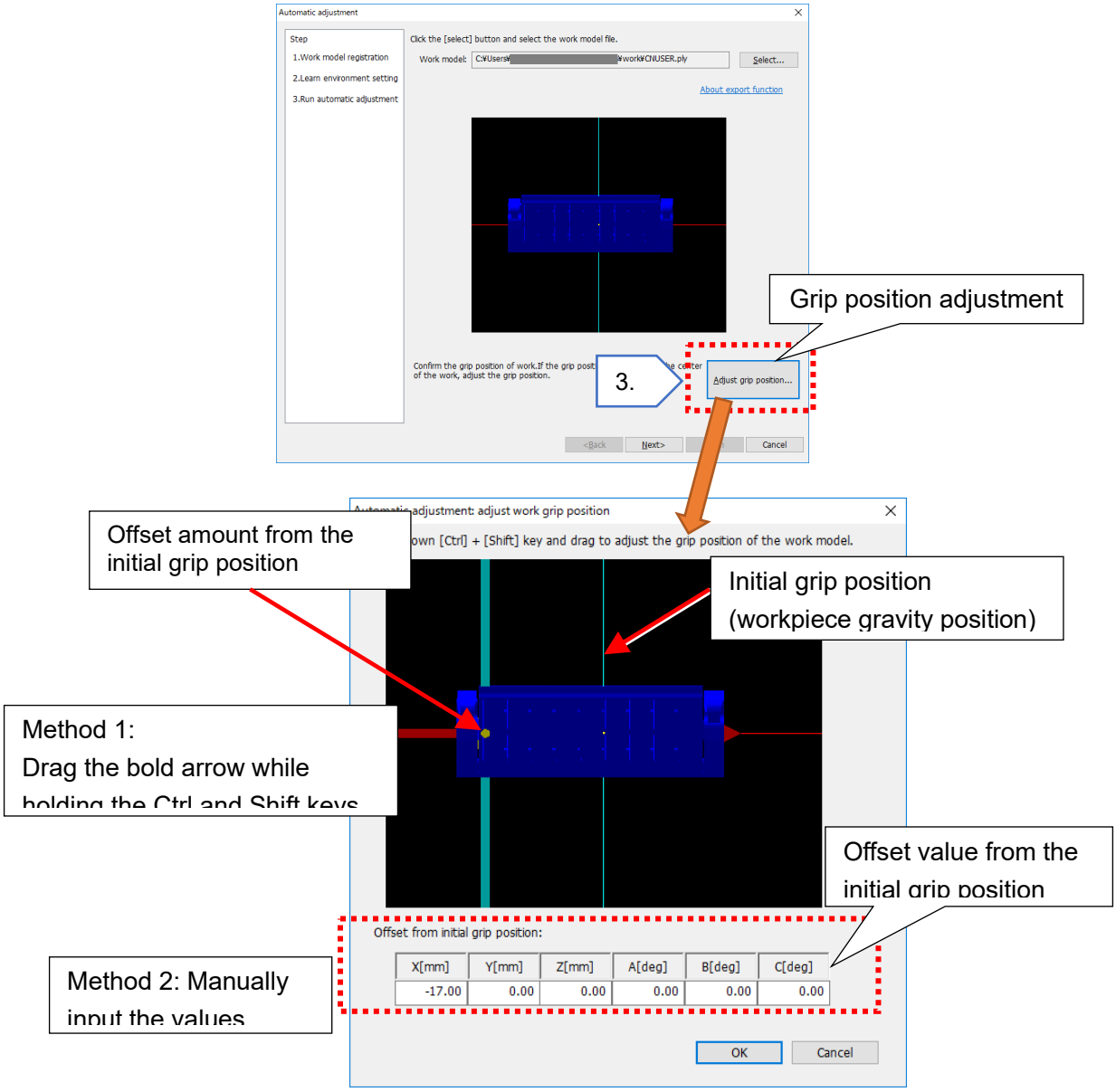


Fig.8-26 Preparing and registering the workpiece model 1

3. Adjust the grip position of the selected workpiece model. Click the [Adjust grip position] button.
4. Click the [OK] button after the adjustment.



<Adjustment method of the workpiece model grip position>

Method 1: Drag the bold arrow while holding the Ctrl and Shift keys to adjust the offset amount from the initial grip position.

Method 2: Manually input the offset values from the initial grip position. The bold arrow indicating the offset from the initial grip position displayed in the window moves by the input values.

・The initial grip position of the workpiece model is indicated by the thin grid line, the offset value from the initial grip position is indicated by the bold arrow.

・As the initial grip position and offset position is the same, the thin grid line and bold arrow are displayed at the same position.

・The workpiece gravity position is used as the initial grip position.

Fig.8-27 Preparing and registering the workpiece model 2

5. The preparation and registration of the workpiece model is completed.
   Click the [Next] button to proceed to the learn environment parameter setting.

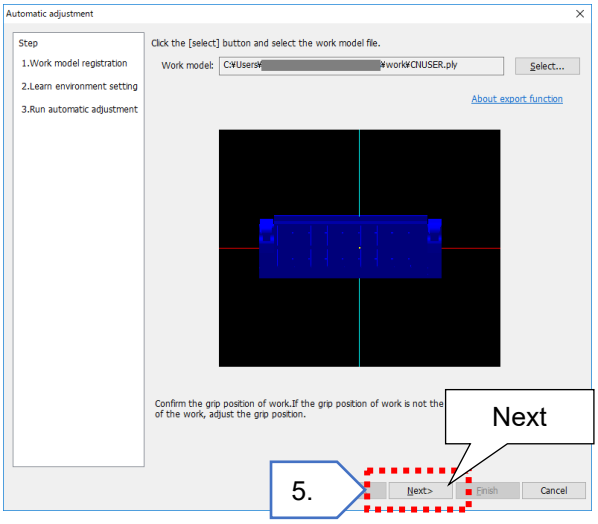


Fig.8-28 Preparing and registering the workpiece model 3

(2) Setting the learning environment parameters

The window displayed for the learn environment parameter setting differs depending on the hand type selected in the hand settings of the job.
As the hand parameters are automatically adjusted in the recognition processing, design the actual hand according to the physical environment (workpiece weight and material).

Types of the window to be displayed

Pattern	Hand type	Description
1	Suction hand	Circular suction pad (The pad diameters in the Xt axis direction and the Yt axis direction are the same.)
2	Suction hand	Oval suction pad (The pad diameters in the Xt axis direction and the Yt axis direction differ.)
3	Tweezers hand	For tweezers hand (3 claws, 4 claws) Adjust the diameter between the claws.
4	Parallel gripping hand	Adjust the hand open width and claw interference range.
5	Internal gripping tweezers hand	For internal gripping tweezers hand (2 claws, 3 claws)
6	Other than the above	

The window to be displayed is explained by using pattern 4 (parallel gripping hand) as an example.
(The windows for other patterns are shown in the following pages.)

■ Pattern 4 (parallel gripping hand)
The parallel gripping hand can optimize the hand open width based on the hand information set in "Specifying settings for the used hand". By setting the search range (Xt axis direction and Yt axis direction) in this window, the claw interference range can be optimized.

1. To optimize the hand open width, select [Optimize hand open width].
2. To optimize the claw interference range, select [Optimize claw interference range] and input the search range (Xt axis direction and Yt axis direction).
3. Input the number of workpieces and box size used for the bulk simulation.
4. Click the [Confirm] button to update the distance image.
5. Check the contents in the window and click [Next] button.

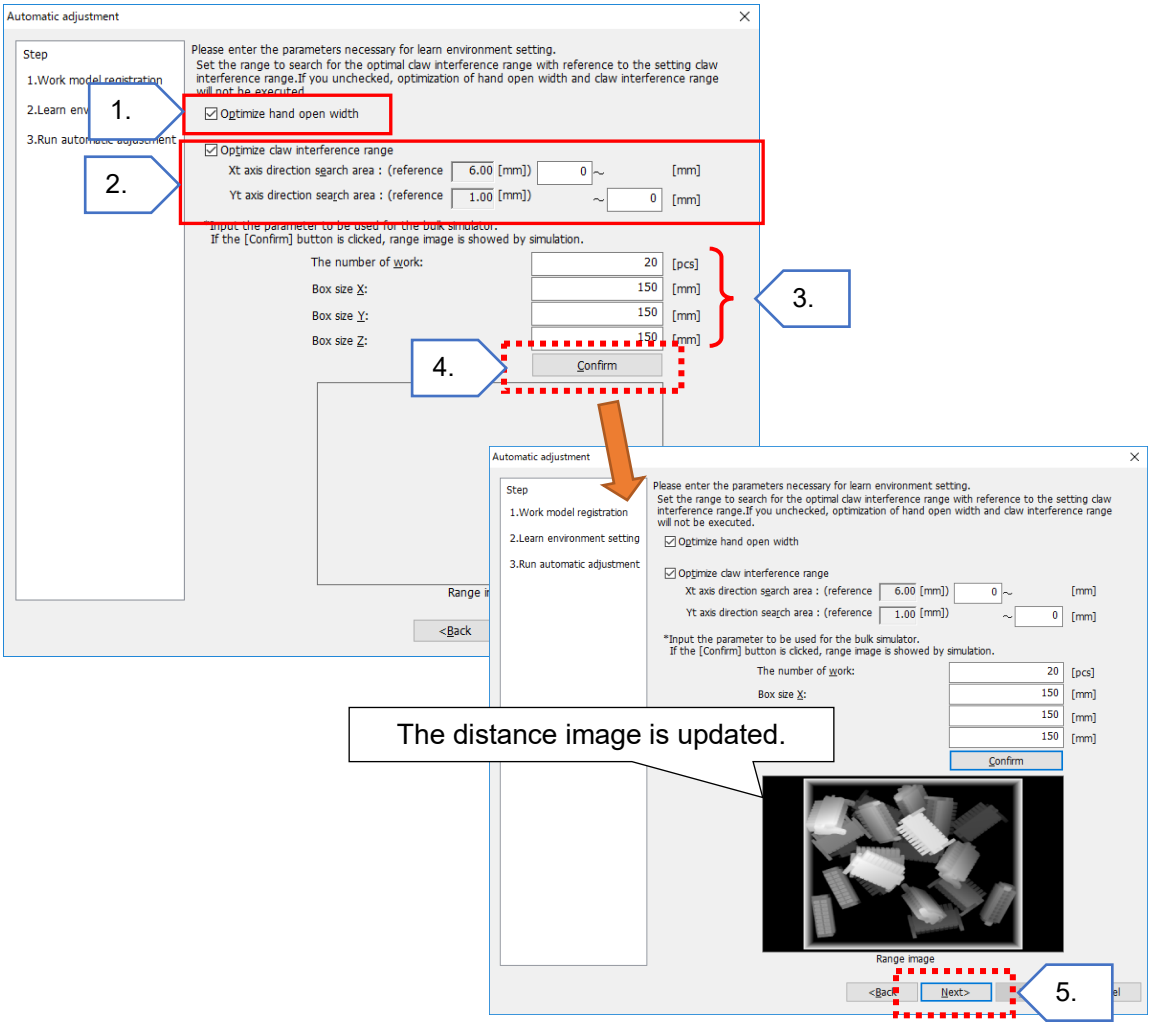
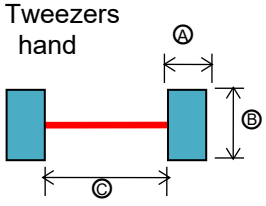


Fig.8-29 Window for pattern 4 (parallel gripping hand)

Parameters of the parallel gripping hand that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
Tweezers hand 	Claw interference diameter Ⓐ (Yt-axis direction)	mm	Yt-axis direction diameter in hand coordinate system	0.50 to 100.00	1.00
	Claw interference diameter Ⓑ (Xt-axis direction)	mm	Xt-axis direction diameter in hand coordinate system	0.50 to 100.00	1.50
	Hand open width Ⓒ	mm	Claw inner side distance when hand open	0.5 to 200.00	5.00

■ Pattern 1 (suction hand and circular suction pad)

When the suction pad is circular (when the pad diameters in the Xt axis direction and the Yt axis direction are the same), the pad diameters can be optimized by setting the search range.

1. To optimize the suction pad diameter, select [Optimize diameter] and input the search range.
2. Input the number of workpieces and box size used for the bulk simulation.
3. Click the [Confirm] button to update the distance image.
4. Check the contents in the window and click [Next] button.

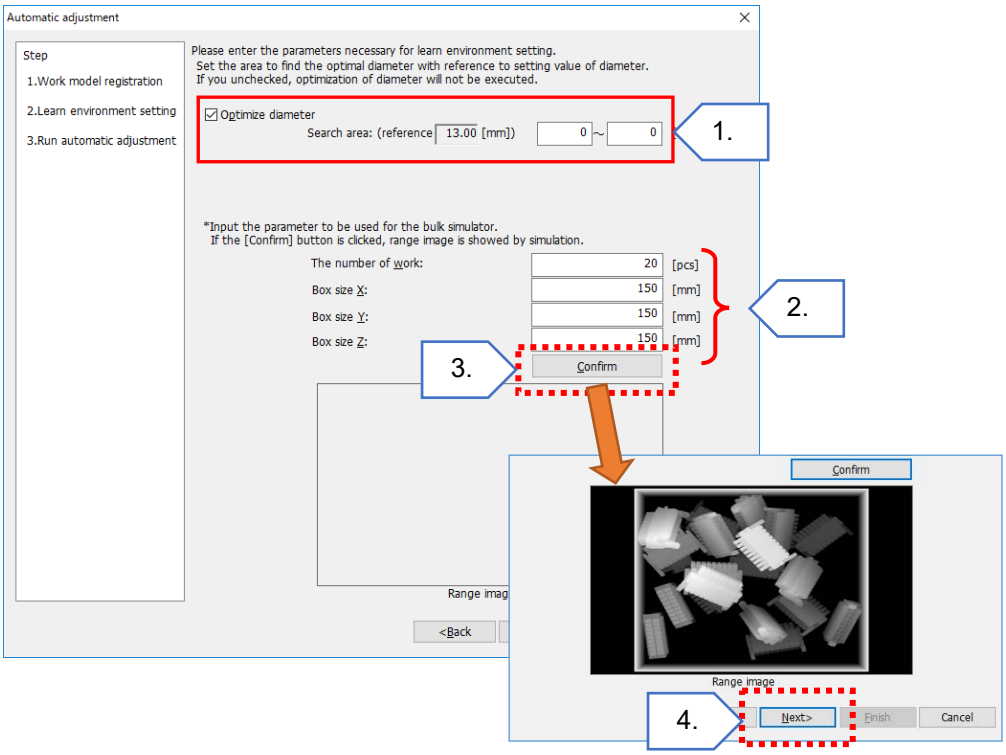
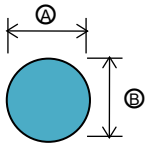


Fig.8-30 Window for pattern 1 (suction hand and circular suction pad)

Parameters of the suction hand (circular suction pad) that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
Suction hand 	Yt-axis direction diameter Ⓐ	mm	Yt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00
	Xt-axis direction diameter Ⓑ	mm	Xt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00

■ Pattern 2 (suction hand and oval suction pad)

When the suction pad is oval (when the pad diameters in the Xt axis direction and the Yt axis direction differ), the pad diameters can be optimized by setting the search range.

1. To optimize the suction pad diameter, select [Optimize diameter] and input the search range (Xt axis direction and Yt axis direction).
2. Input the number of workpieces and box size used for the bulk simulation.
3. Click the [Confirm] button to update the distance image.
4. Check the contents in the window and click [Next] button.

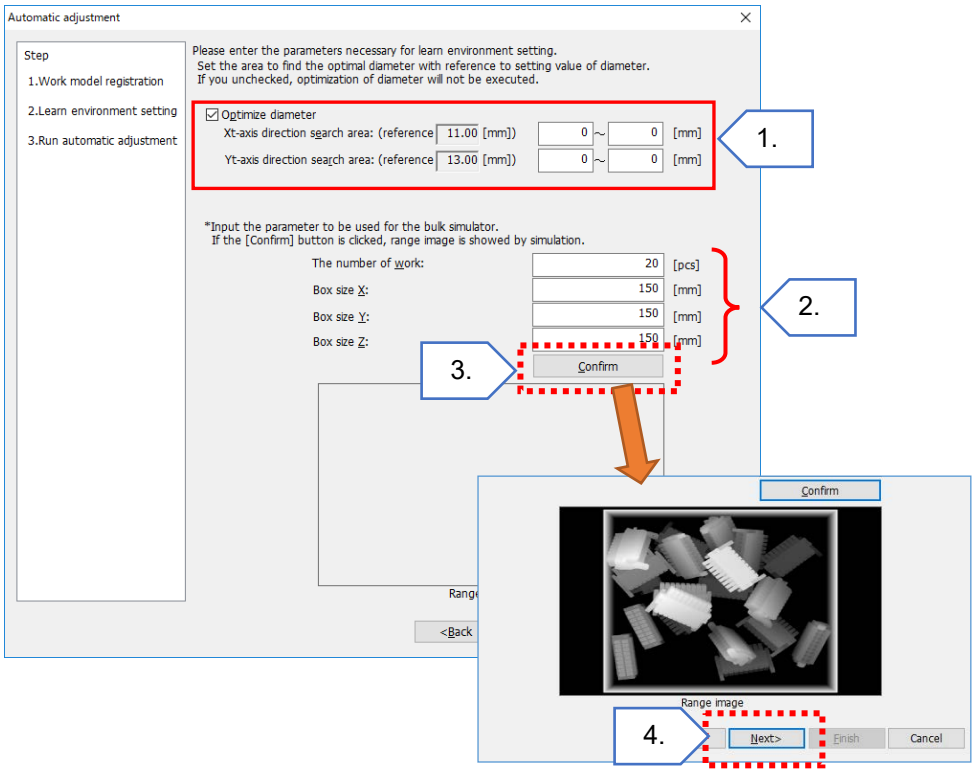
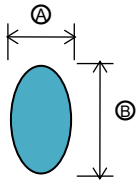


Fig.8-31 Window for pattern 2 (suction hand and oval suction pad)

Parameters of the suction hand (oval suction pad) that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
Suction hand 	Yt-axis direction diameter Ⓐ	mm	Yt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00
	Xt-axis direction diameter Ⓑ	mm	Xt-axis direction diameter in hand coordinate system	0.50 to 100.00	2.00

■ Pattern 3 (tweezers hand/3 claws, 4 claws)

For the tweezers hand (3 claws, 4 claws), the diameter between claws can be optimized.

1. Select [Optimize diameter] to optimize the diameter between claws.
2. Input the number of workpieces and box size used for the bulk simulation.
3. Click the [Confirm] button to update the distance image.
4. Check the contents in the window and click [Next] button.

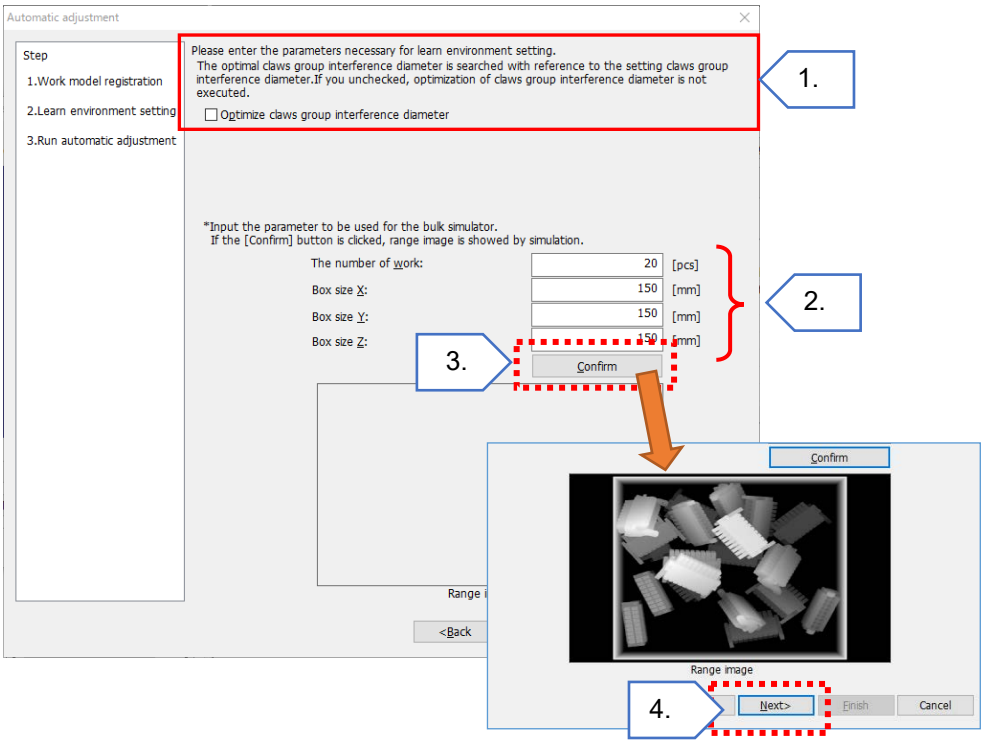
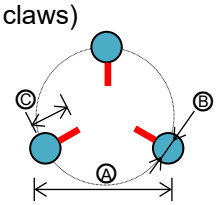
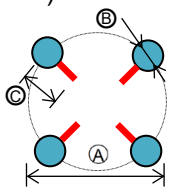


Fig.8-32 Window for pattern 3 (tweezers hand)

Parameters of the suction hand (tweezers hand and oval suction pad) that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
Tweezers hand (3 claws) 	Claws group interference diameter Ⓐ	mm	Diameter of interference area consists of claws when hand open	0.50 to 200.00	10.00
Tweezers hand (4 claws) 	Claws group interference diameter Ⓐ	mm	Diameter of interference area consists of claws when hand open	0.50 to 200.00	10.00

■ Pattern 5 (internal gripping tweezers hand/2 claws, 3 claws)

For the internal gripping tweezers hand (2 claws, 3 claws), optimize the hand open width.

1. Input the number of workpieces and box size used for the bulk simulation.
2. Click the [Confirm] button to update the distance image.
3. Check the contents in the window and click [Next] button.

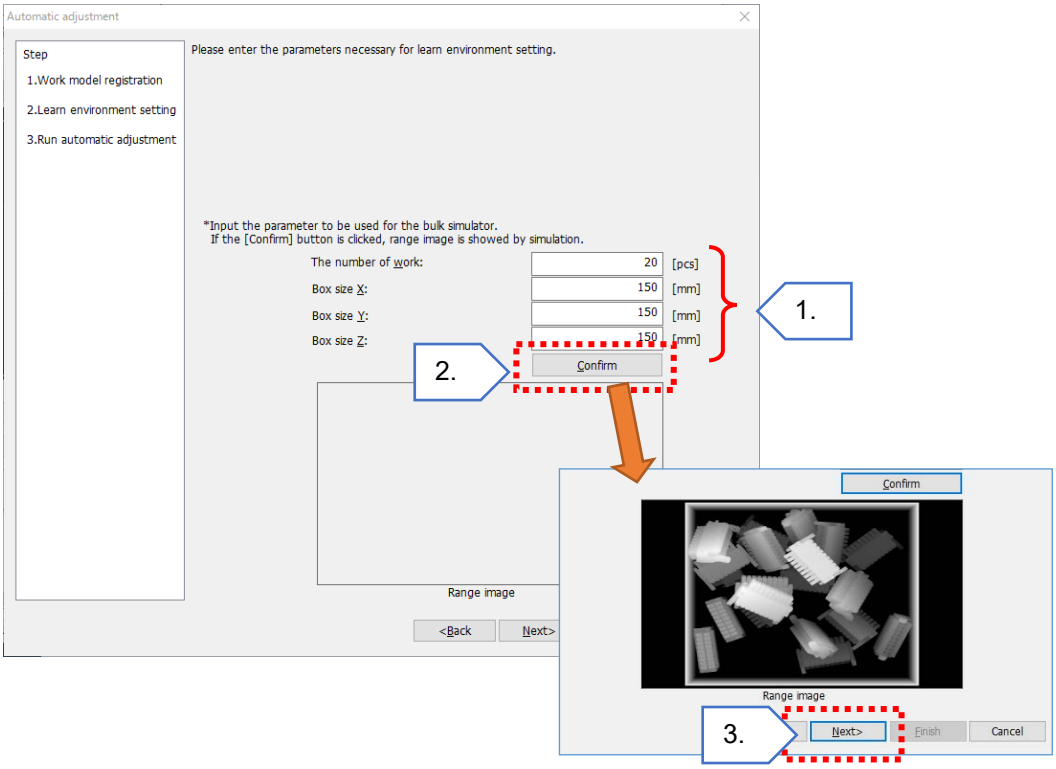
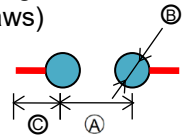
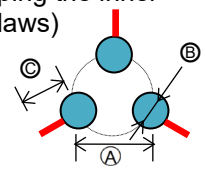


Fig.8-33 Window for pattern 5 (internal gripping tweezers hand/2 claws, 3 claws)

Parameters of the internal gripping tweezers hand (2 claws, 3 claws) that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
weezers hand gripping the inner (2 claws) 	Hand open width c	mm	Claw center point distance when hand open	0.50 to 100.00	5.00
Tweezers hand gripping the inner (3 claws) 	Hand open width c	mm	Claw center point distance when hand open	0.50 to 100.00	5.00

■ Pattern 6 (hand other than pattern 1 to 5)

For the hand other than pattern 1 to 5 in the previous page, the hand open width can be optimized.

1. To optimize the hand open width, select [Optimize hand open width].
2. Input the number of workpieces and box size used for the bulk simulation.
3. Click the [Confirm] button to update the distance image.
4. Check the contents in the window and click [Next] button.

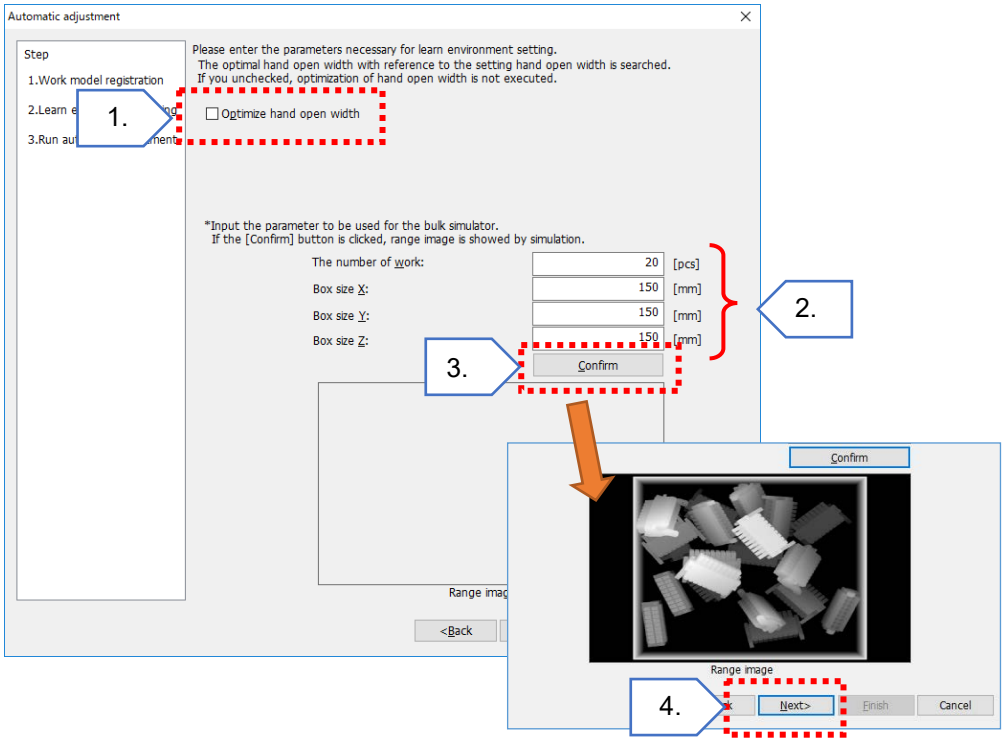
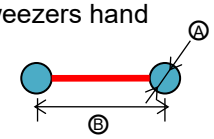
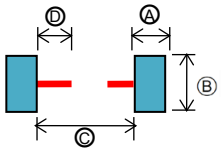
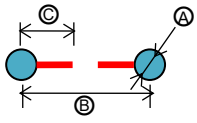


Fig.8-34 Window for pattern 6 (hands other than patterns 1 to 5)

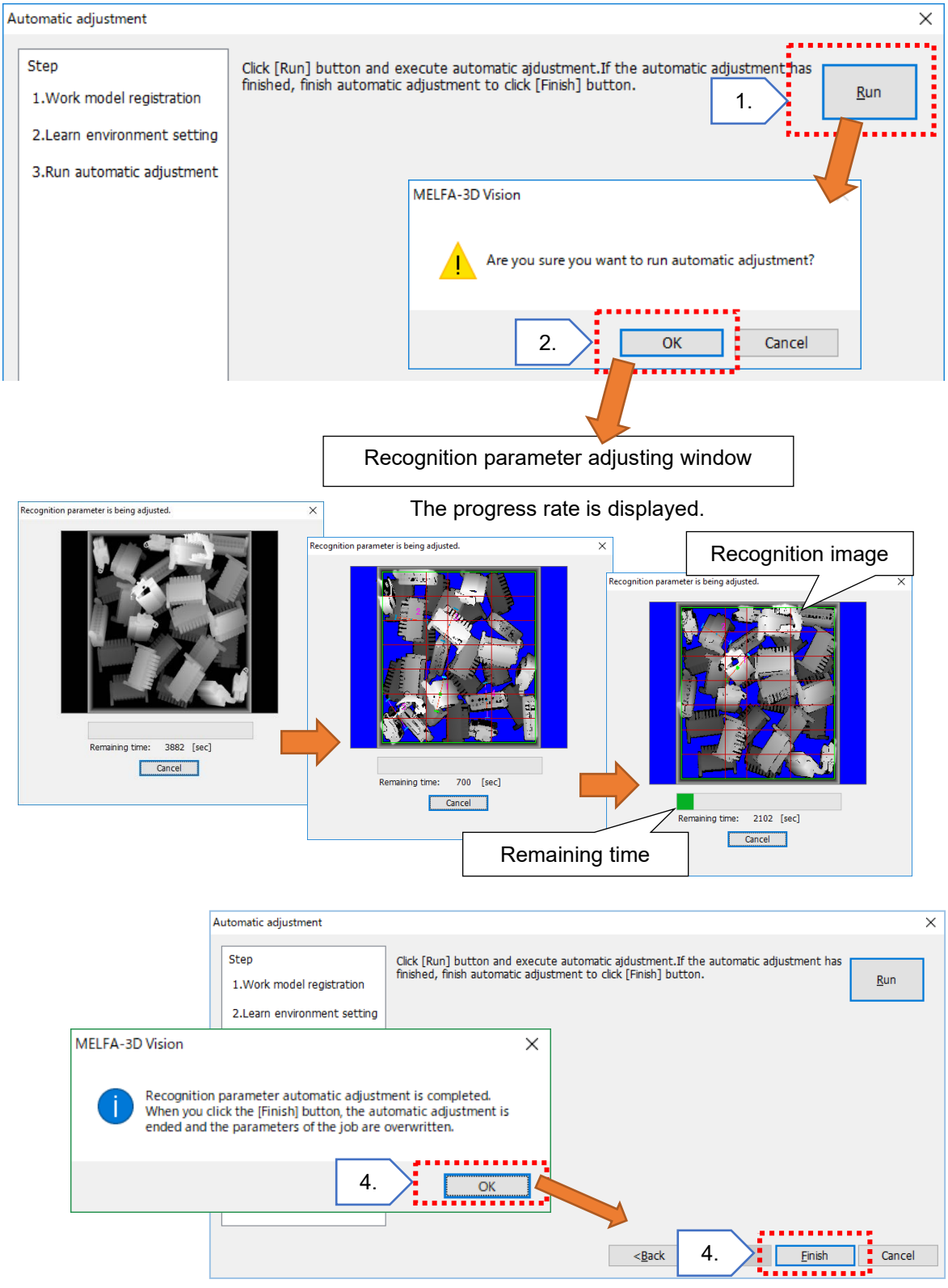
Parameters for the hand other than pattern 1 to 5 that can be optimized

Hand type	Parameter	Unit	Description	Range	Default setting
Tweezers hand 	Hand open width B	mm	Claw center point distance when hand open	0.50 to 200.00	5.00
Parallel hand (Limited stroke) 	Hand open width C	mm	Claw inner side distance when hand open	0.50 to 200.00	5.00
Tweezers hand (Limited stroke) 	Hand open width B	mm	Claw center point distance when hand open	0.50 to 200.00	5.00

(3) Executing the automatic adjustment

1. Click the [Run] button in the Automatic adjustment screen after setting the learn environment parameters.
2. A confirmation window appears. Click [OK] to execute automatic adjustment.
3. The progress rate and recognition image are displayed in the recognition parameter adjusting window.
4. When the automatic adjustment of the recognition parameter is completed, a completion message appears. Click the [OK] button in the message window and then click the [Finish] button in the Automatic adjustment screen. The Automatic adjustment screen closes and the parameter of the job is overwritten.

Fig.8-35 Executing the automatic adjustment



(4) Actual environment adaptive parameter

Adjust the following parameter at step 2 in the Model-less Recognition Parameter Setting screen according to the customer's actual environment.

Floor height

Recognition range: X start point/X finish point/Y start point/Y finish point

Number of recognition area divisions: Horizontal/Vertical

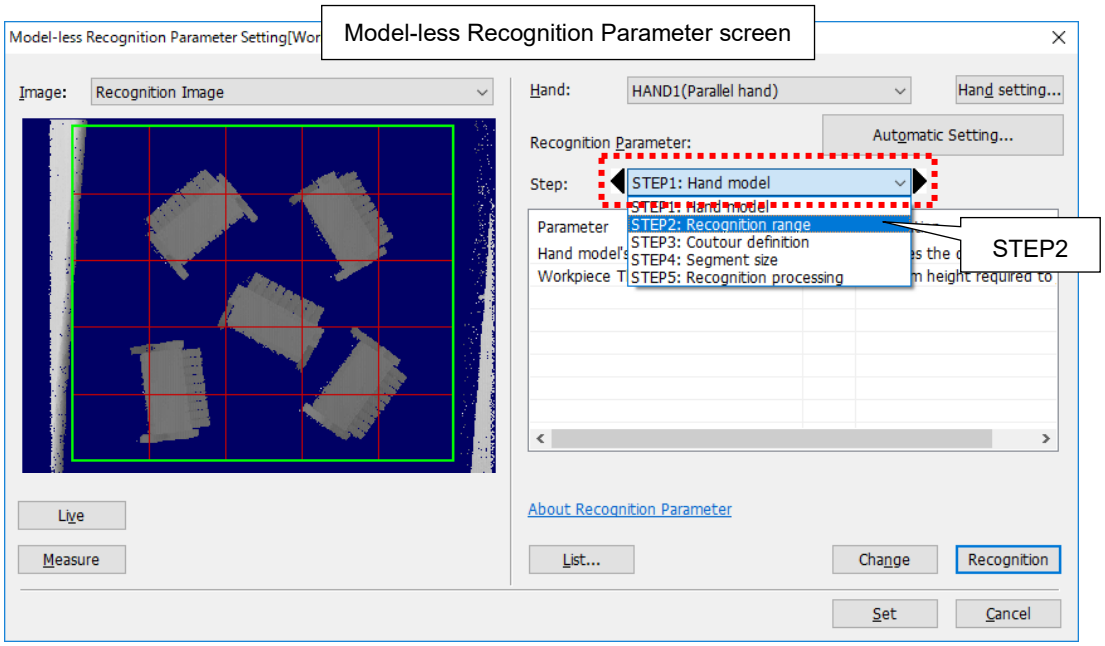
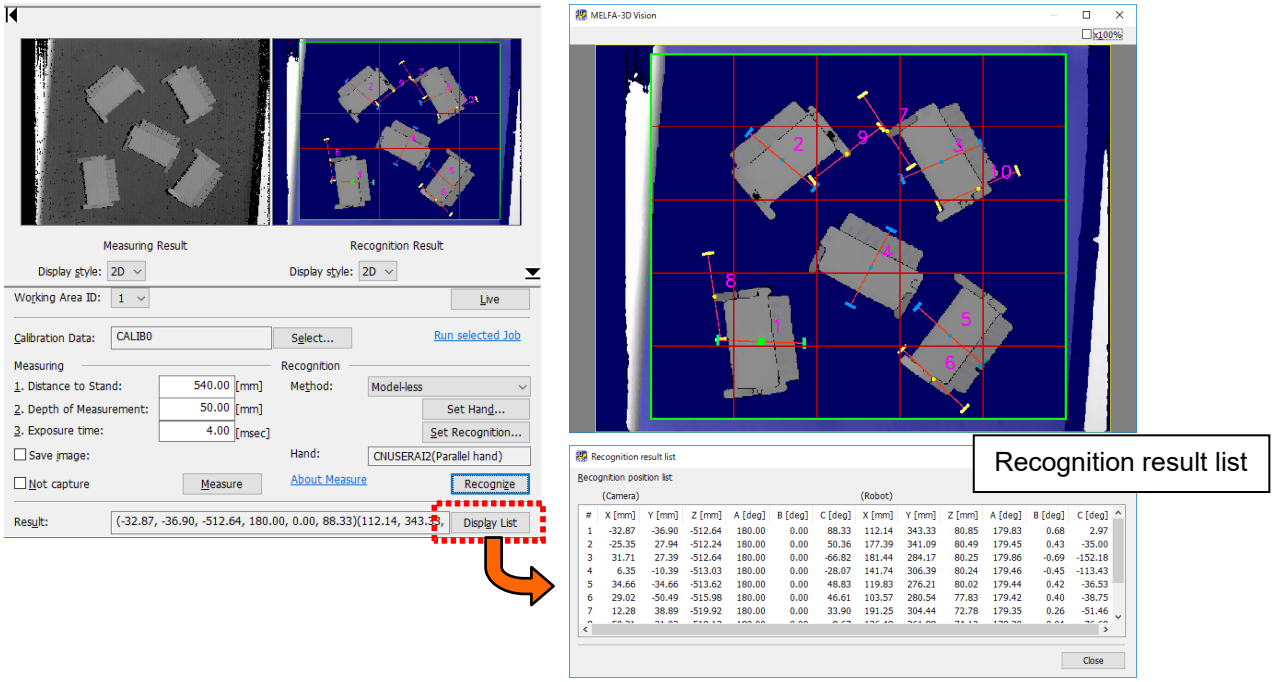


Fig.8-36 Actual environment adaptive parameter

8.3.1.5. Checking the recognition results

Change the position of the workpiece in the measurement range, or increase the number of workpieces.
Click the [Measure] button to perform measurement, and then click the [Recognize] button to perform recognition. Recognition result with the highest score is drawn in green, the recognized position values are displayed in the Result field.
Other color meanings: Yellow: Results from full search, Blue: Results from segment search.
By clicking the [Display list] button, other results can also be viewed. Please note that the results are displayed in the list in order from the higher score.
Although the parting line (red line) of the recognition results in the setting window may not be displayed, using it has no effect. To confirm parting lines which are not displayed, click the image of the recognition results and then display the enlarged image screen.

The recognition results are the hand coordinate system position and posture viewed from the camera coordinate system (see 2.4.4 Camera coordinate system).

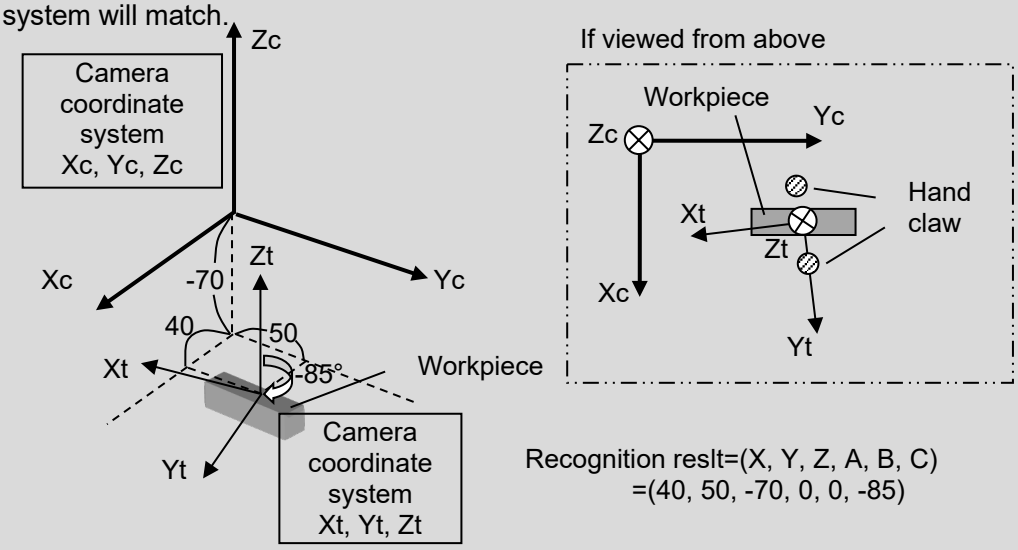


* For the camera coordinates, refer to "2.4.4 Camera coordinate system". For the robot coordinates, refer to the instruction manual "Detailed explanations of functions and operations".

Fig.8-37 Confirmation of the recognition results

◇◆◇Recognition results◇◆◇

The position at the top of the workpiece surface is returned for the recognition result Z component. Furthermore, the C component is the rotation angle (-90° ≤ C < 90°) around the hand coordinate system Z-axis in the camera coordinate system. Please note that if X, Y, Z, A, B, and C in the recognition results are all 0, the camera coordinate system and the hand coordinate system will match.



If there are no problems with the results, click the [Execute the job being edited] link to proceed to job execution.

8.3.2. Model matching recognition

Model matching recognition is a method used to search for a shape similar to shape information created from workpiece 3D-CAD model data. The three-dimensional orientation of workpieces can be detected, and the output position information contains the **X, Y, Z, A, B, and C components.** This is the recognition position, and differs from the grip position. Consequently, it is necessary to calculate in advance the "Correction vector" to correct the deviation between the recognition position and the grip position as shown in Fig.8-38. By calculating the grip position from the recognition position using the correction vector, workpieces can be gripped.
Only RV-F series/RV-FR series robots, and ENSENSO N35 series cameras support model matching recognition.

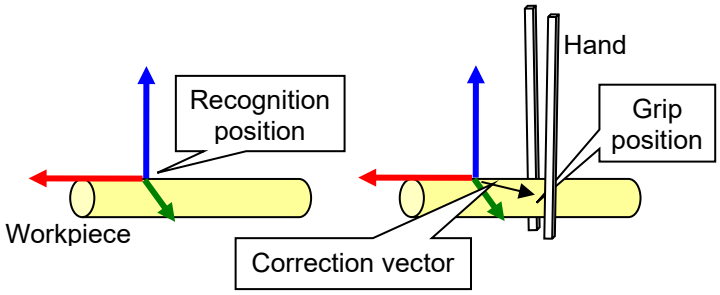


Fig.8-38 Difference between recognition position and grip position

8.3.2.1. 3D-CAD model preparation

Pay attention to the following when creating 3D-CAD models.

- Create so that the origin is near the center of the CAD model.
- Use the CAD coordinate system XY plane as the floor surface, and arrange the workpiece position to get the **most** stable posture.

◇◆◇3D-CAD model origin◇◆◇
If manipulating the 3D-CAD model viewpoint on RT ToolBox3, the viewpoint can be changed with the **model origin as the rotational center**. Consequently, the closer the model center and CAD origin are to one another, the easier the operability when rotating.

◇◆◇Stable posture◇◆◇
This refers to a posture to enable self-standing of the workpiece in a stationary state without the need for any support.

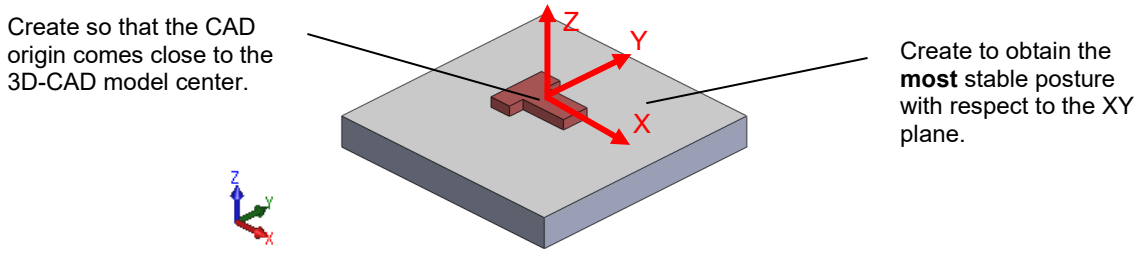


Fig.8-39 3D-CAD model creation example

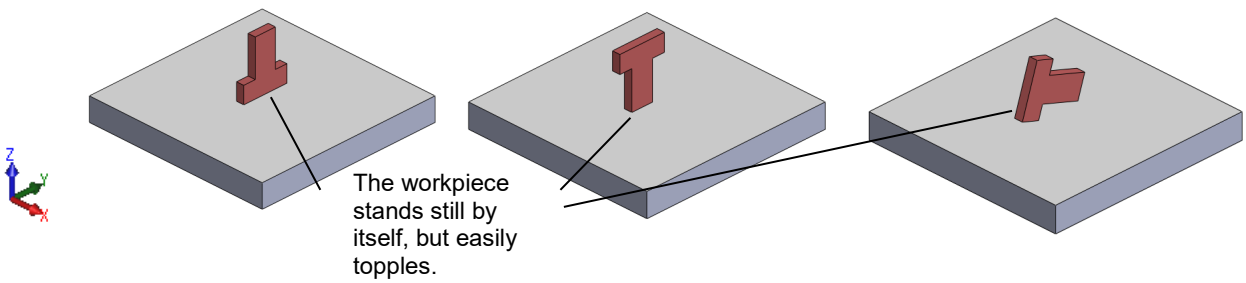


Fig.8-40 Example of other unstable postures

8.3.2.2. Selecting the recognition method

Select "Model matching" from the drop-down menu. This setting is not available when an ENSENSO N36 series camera is connected.

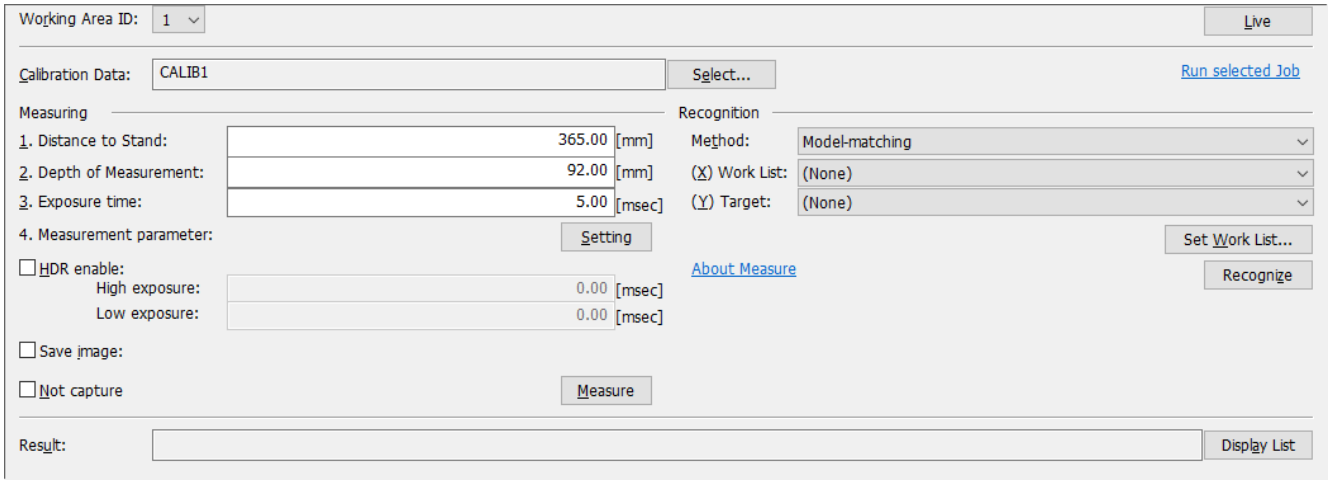
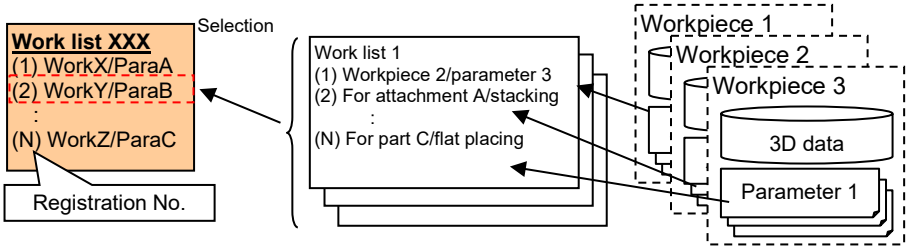


Fig.8-41 Selection of the recognition method (model matching recognition)

The table below describes the items, workpiece list and recognition target, that appear when the model matching is selected.

Table 8-14: Workpiece list and recognition target

Item name	Description
Work List	A list of combinations of the registered workpieces and parameters to be used. In a job, select the combinations to be used in the work list. In the robot program, the numbers registered in the work list are specified. 
Target	Target of the recognition test which is performed when the [Recognize] button is pressed. As well as the registration numbers, workpiece names and parameter names are also displayed.
Set Work List button	Opens the Create workpiece list screen. The following tasks can be carried out at the Create workpiece list screen. (1) Conversion to a dedicated data format from 3D-CAD data (2) Recognition using arbitrary parameter values (3) Creation of workpiece lists from registered workpieces/parameters

8.3.2.3. Workpiece registration

Click the [Set Work List] button to open the Work list settings screen, and then click the [Register Work] button in the screen. Then, by clicking the workpiece field [Add] button in the [Register Work] screen, the [Add Work] screen appears.

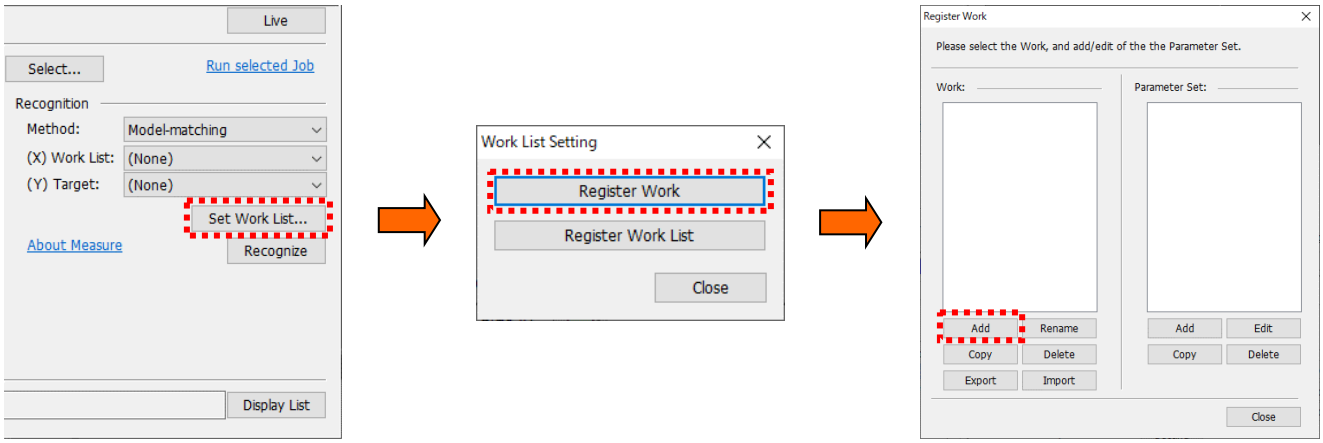


Fig.8-42 Workpiece list settings and workpiece registration

Perform the following four steps to register workpieces at the Workpiece addition screen.

(1) (a) 3D-CAD model selection

Click the model file selection [Select] button in the Workpiece addition screen, and then select the 3D-CAD data (STL format Note 1 or OBJ format or PLY format) to be used. By selecting the 3D-CAD model, data is converted to a dedicated format and edge detection is performed in the control unit. After approximately 10 to 30 seconds, the images before and after processing are updated.

Note 1: Compatible with both binary and text formats.

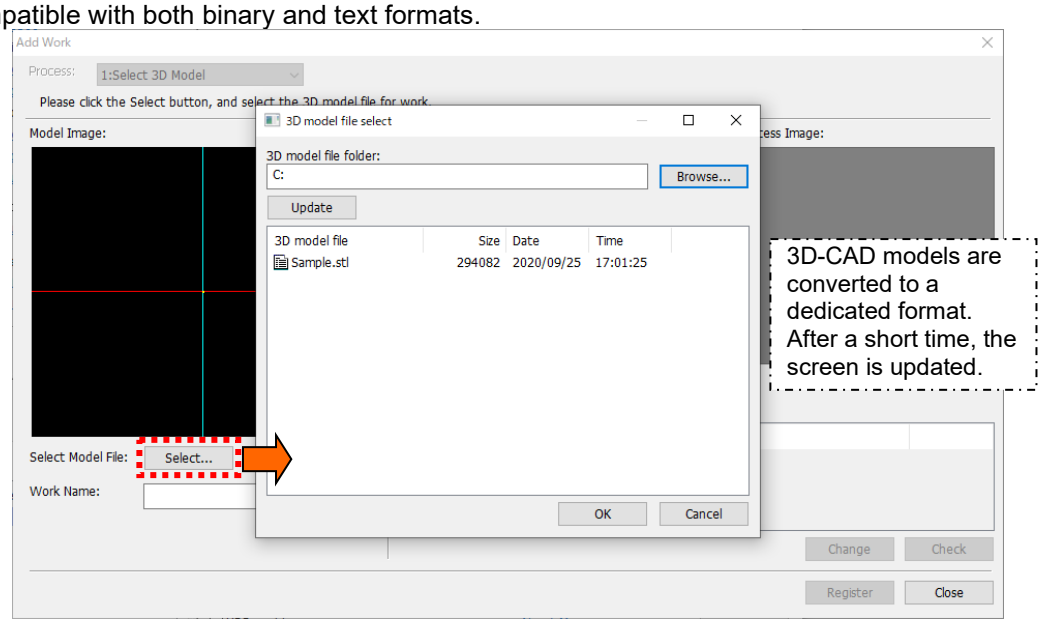


Fig.8-43 Workpiece addition

(2) (b) Edge detection

Select "2: Edge detection" from the processing step combo box. The image after edge detection from the 3D-CAD model appears in the image after processing.

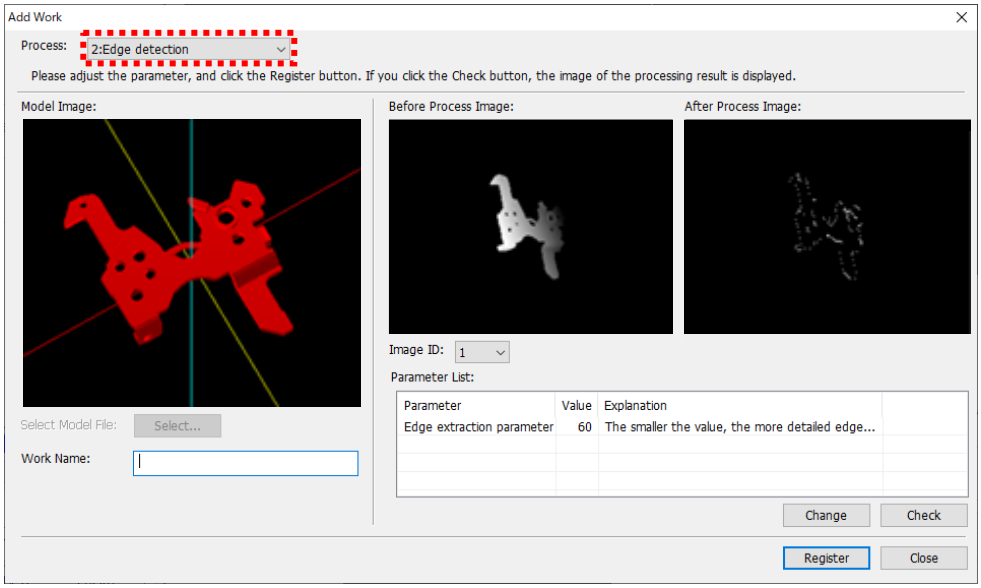


Fig.8-44 Edge detection

Table 8-15: Parameter for edge detection

Parameter	Unit	Description	Range	Default setting
Edge extraction parameter	-	The smaller the value, the more detailed edge extraction is performed, however, the speed drops.	1 to 500	60

By clicking images before or after processing, an enlarged image screen appears in a pop-up window. The window can be closed by clicking the enlarged image screen.

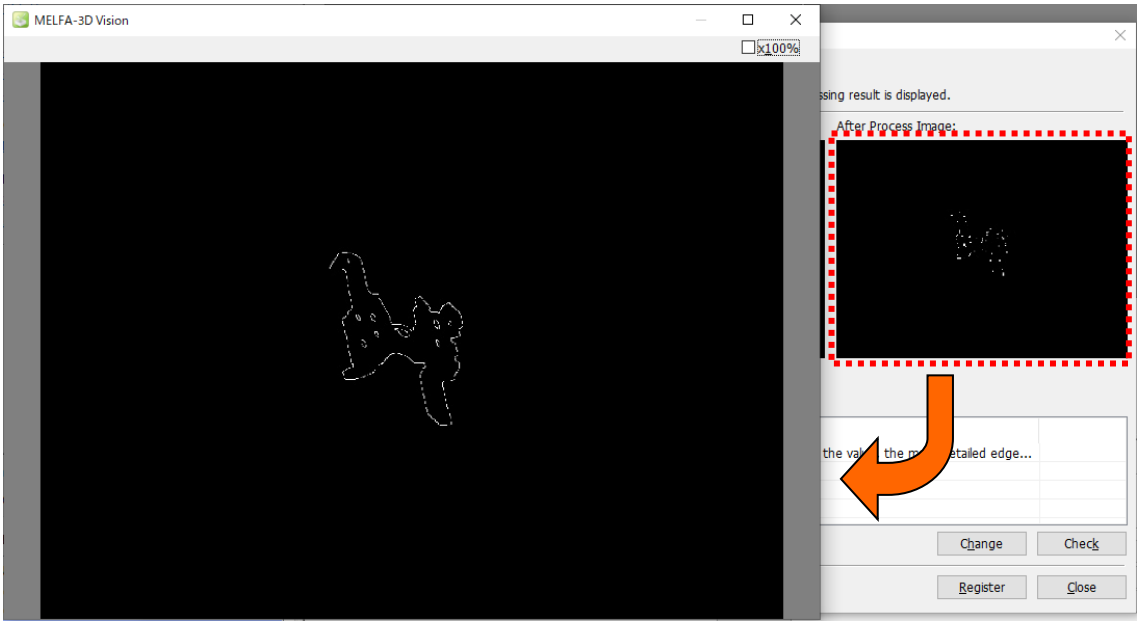


Fig.8-45 Enlarged image

Check the enlarged image screen for the image after processing to ensure that edges are detected as described in Table 8-16.

Table 8-16: Check items for edge detection

No.	Check item	Remedy
1	Is the edge detected on a flat surface?	If the edge is detected on a flat surface, increase the "Edge extraction parameter" to ensure that edges are not detected on a flat surface.
2	Is it possible to imagine the shape of the model image before processing from the displayed image?	If unable to imagine the shape of the model image, reduce the "Edge extraction parameter" so that the shape can be imagined from the edge.

By selecting the parameter in the parameter list and clicking the [Change] button, the parameter value can be changed.

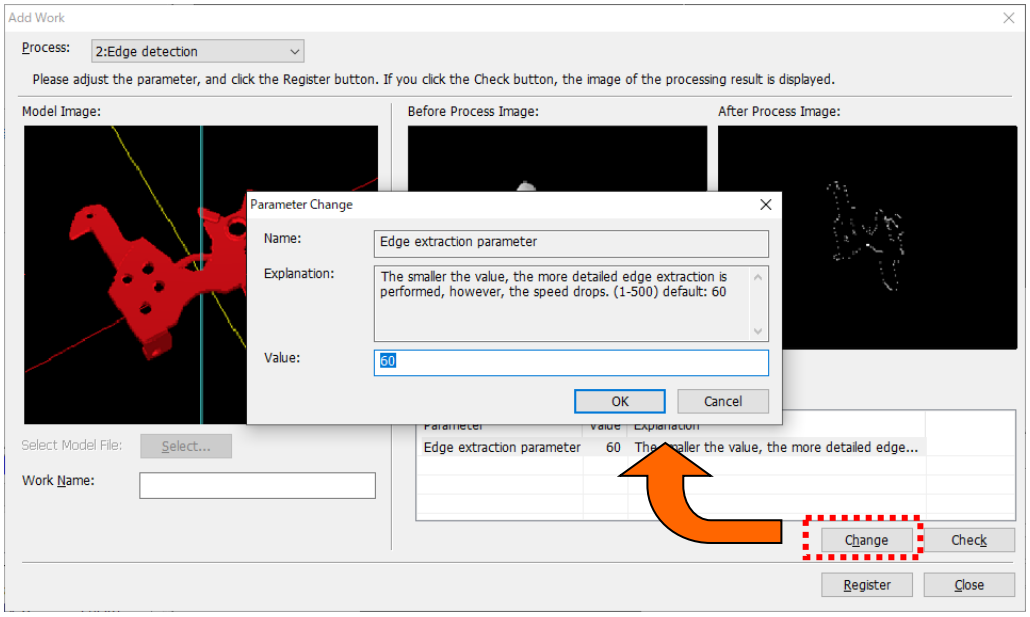


Fig.8-46 Parameter change

By clicking the [Check] button after changing the parameter value, edge detection processing is performed again. After a short while, the images before and after processing are updated.

By changing the [Image ID] in the Workpiece addition screen, it is possible to display images before and after processing from eight viewpoints. Ensure that edge detection satisfies Table 8-16 also for the remaining seven viewpoints, and if not, adjust the parameter.

(3) (c) Sampling of point

Select "3: Sampling of point" from the processing step combo box. The image in which points are sampled from straight lines is displayed in the image after processing. Please note that sampled points appear in red.

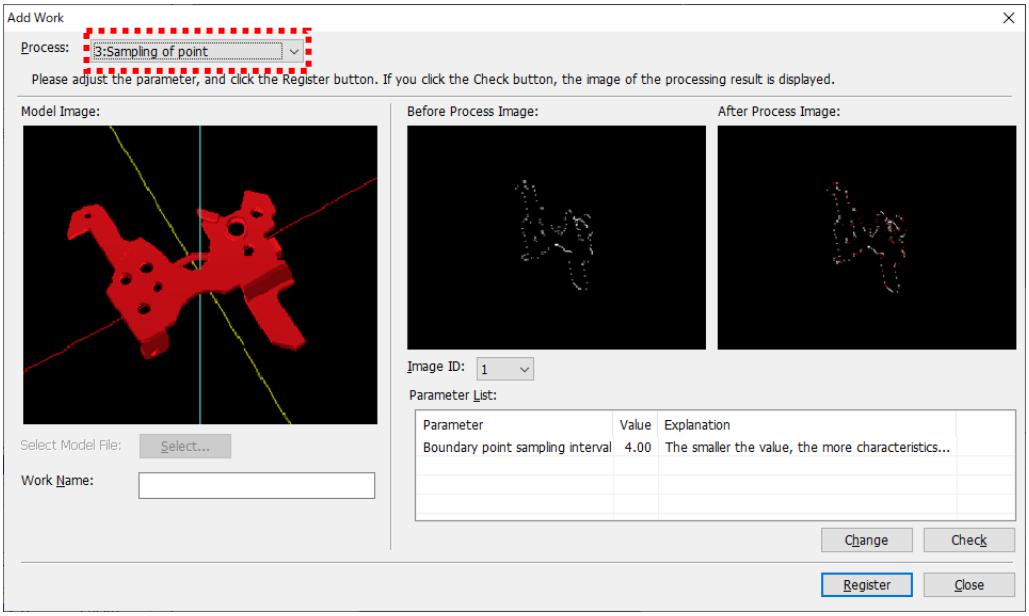


Fig.8-47 Sampling of point

Table 8-17: Parameter for point sampling

Parameter	Unit	Description	Range	Default setting
Boundary point sampling interval	-	The smaller the value, the more characteristics are extracted, however, the speed drops.	1.00 to 100.00	4.00

Check the enlarged image screen for the image after processing to ensure that points are sampled.

Fig.8-48 Successful example for sampling of point

Ensure that points are sampled also in the remaining seven viewpoints, and if not, adjust the parameter.

(4) (d) Tangent line detection

Select "4: Tangent line detection" from the processing step combo box. The image in which tangent lines are detected from the edge is displayed in the image after processing. Please note that detected tangent lines appear in green.

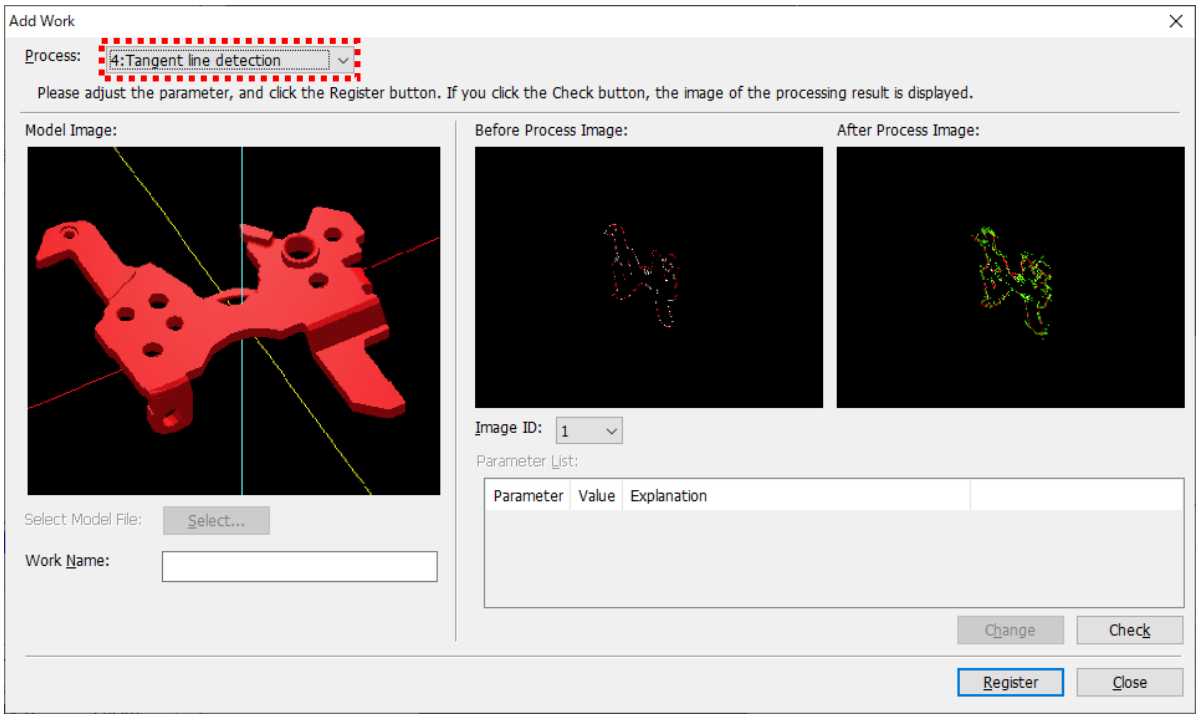


Fig.8-49 Tangent line detection

Check the enlarged image screen for the image after processing to ensure that straight lines are detected as in Fig.8-50.

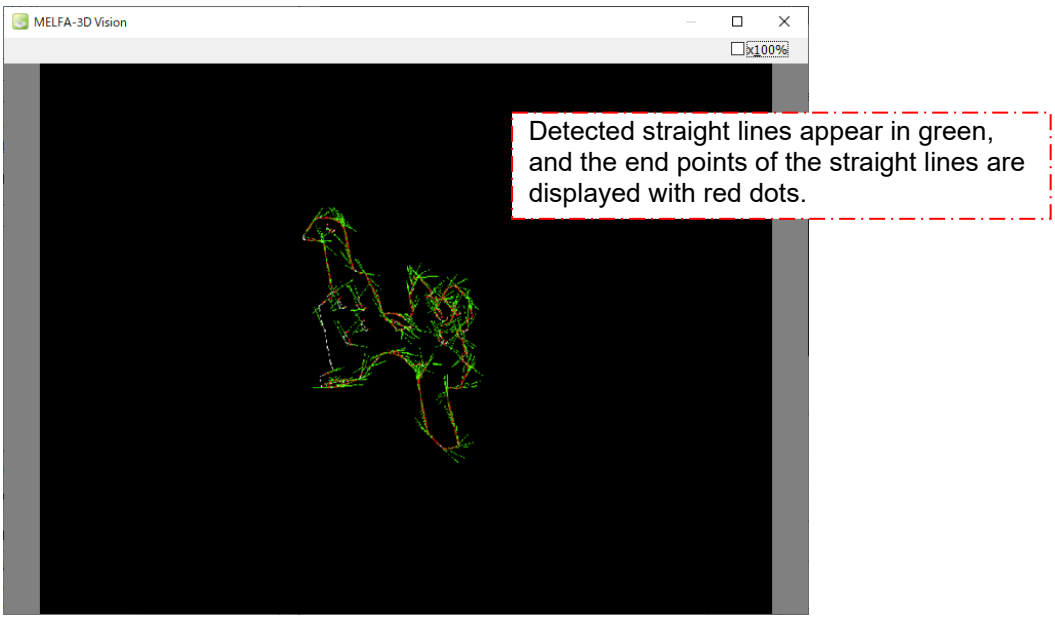


Fig.8-50 Straight line successful example

When adjustment is completed, enter the workpiece name Note 1, and then click the [Register] button. It is necessary to wait a short while until this process is completed. Note 2

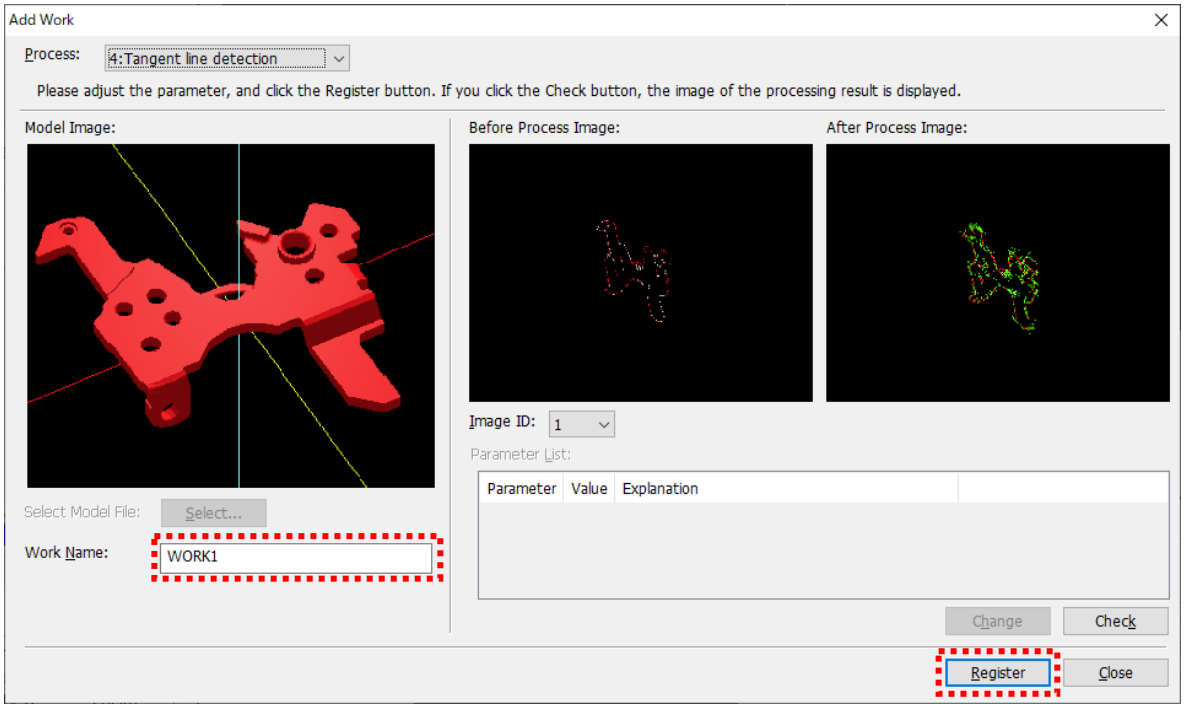


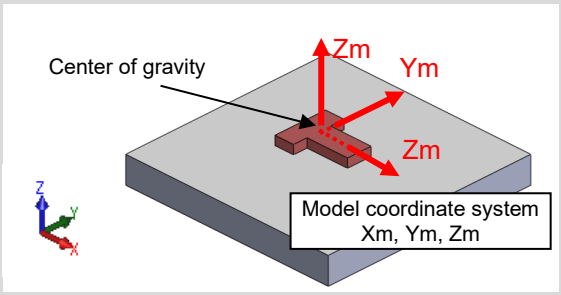
Fig.8-51 Registration of workpiece

Note 1: Up to 32 single-byte alphanumeric characters. However, use alphabet characters only for the leading character.

Note 2: In the event registration takes time, the processing time can be shortened by increasing the value of "Boundary point sampling interval". However, the recognition rate may decrease if the value of this parameter is large.

◇◆◇Model coordinate system◇◆◇

When registering workpieces, the model coordinate system is set for the workpiece. The origin is the workpiece center of gravity, and the X-, Y-, and Z-axis directions match the CAD data coordinate system.



■ Exporting, importing model matching data
Model matching data (workpiece registration data and parameter set) for registered workpieces can be exported and imported. For exporting, click the [Export] button to display a Save model matching data screen, and save the data with an arbitrary name.

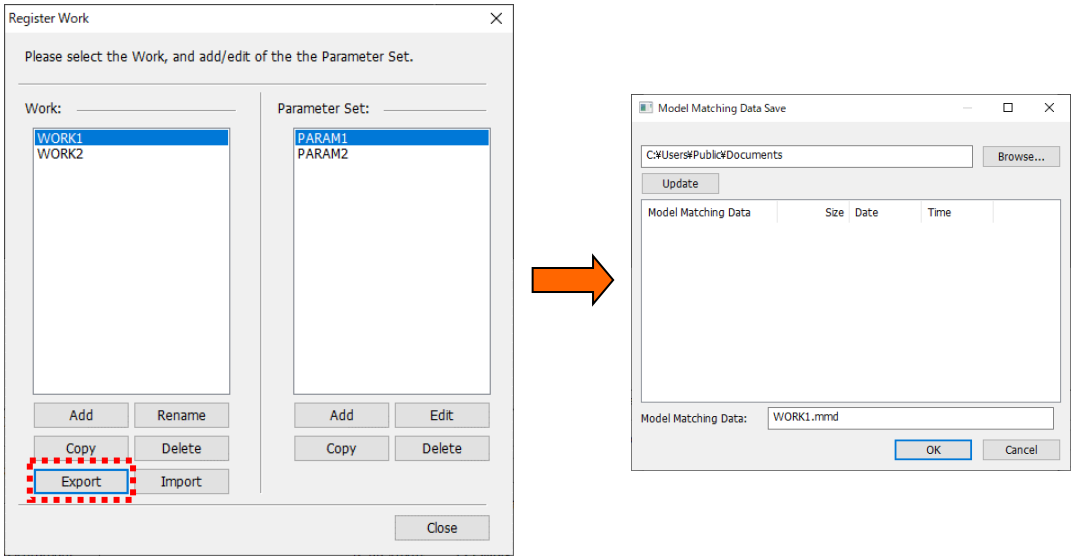


Fig.8-52 Parameter set editing

For importing, click the [Import] button to display a Select model matching data screen, and then select the workpiece data to be imported.

■ Parameter set registration
For registration of the parameter set, set recognition parameters used when recognizing workpieces registered from measured images.

By clicking the [Add] button below the parameter set list at the Workpiece registration screen, a screen for entering the parameter set name appears. Enter an arbitrary name Note 1 and click the [OK] button.

Note 1: Up to 32 single-byte alphanumeric characters

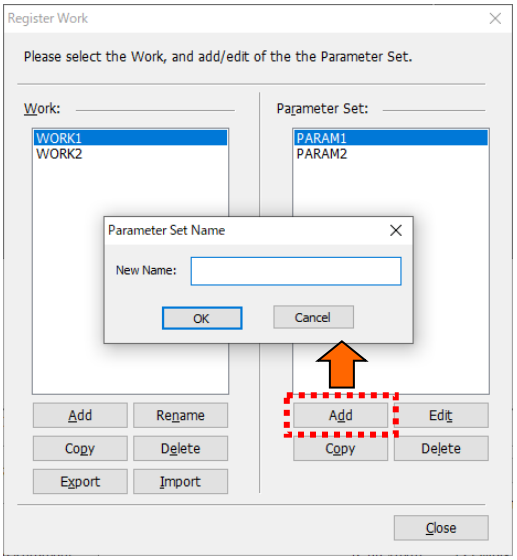


Fig.8-53 Parameter set addition

Select the name of the added parameter set and click the [Edit] button.

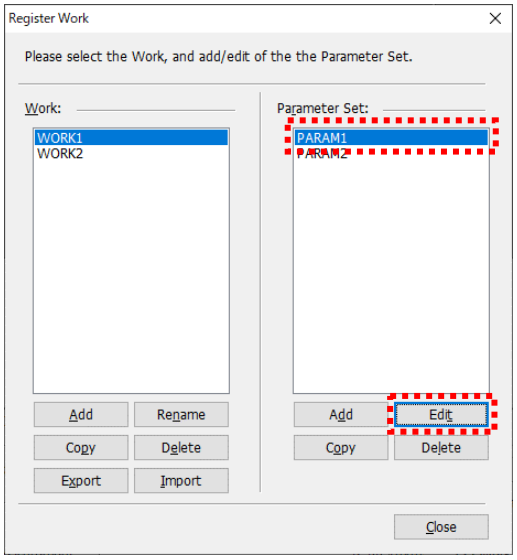


Fig.8-54 Parameter set editing

(a) Distance image → edge detection
The image in which straight lines are detected from the edge is displayed in the image after processing. This processing will take a little time. Wait a short while until recognition images are updated.
When the recognition image is displayed, select "After process" option to change the image display, and display the image for which edges were detected.

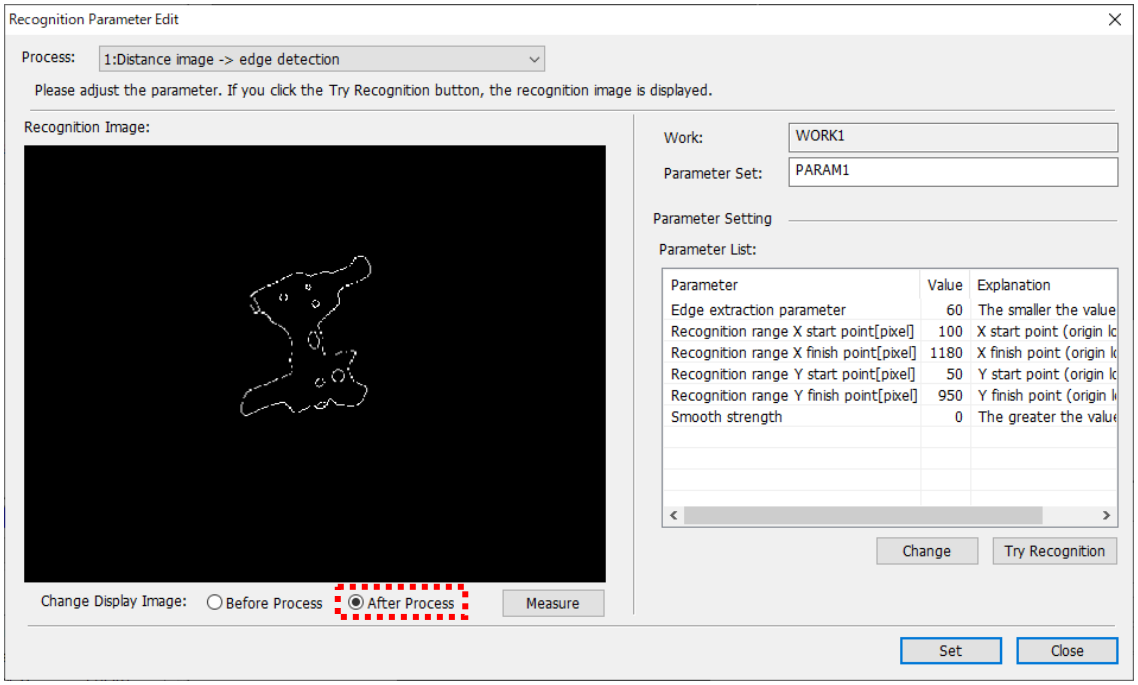
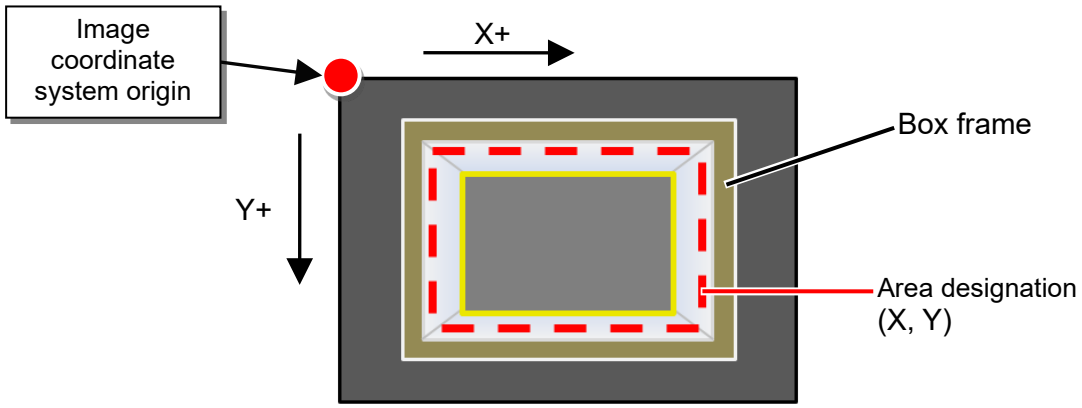


Fig.8-55 Edge detection

Table 8-18: Parameter edge detection for recognition

Parameter	Unit	Description	Range	Default setting
Edge extraction parameter	-	The smaller the value, the more detailed edge extraction is performed, however, the speed drops.	1 to 500	60
Recognition range X start point Note 1	pixel	X start point (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	0 to 1270	100
Recognition range X finish point Note 1	pixel	X finish point (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	0 to 1279	1180
Recognition range Y start point Note 1	pixel	Y start point (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	0 to 950	50
Recognition range Y finish point Note 1	pixel	Y finish point (origin located at the top left corner of the screen, right direction X+, lower direction Y+)	0 to 959	950
Smooth strength	-	The greater the value, the more noise is reduced.	0: No filter 1 to 4	0

Note 1: As the recognition range widens, the recognition time gets longer. Specify the range.
Upper left: Origin, Right direction: +X, Down direction: +Y.



Viewpoint looking down from the camera side

Fig.8-56 Explanatory drawing for the recognition area

By clicking the recognition image screen, an enlarged image screen appears in a pop-up window. The window can be closed by clicking the enlarged image screen.

Fig.8-57 Enlarged image

Check the enlarged image screen for the recognition image after processing to ensure that edges are detected as in Table 8-19.

Table 8-19: Check items for edge detection

No.	Check item	Remedy
1	Is the edge detected on a flat surface?	If the edge is detected on a flat surface, increase the "Edge extraction parameter" to ensure that edges are not detected on a flat surface.
2	Is it possible to imagine the shape of the model image before processing from the displayed edge?	If unable to imagine the shape of the model image, reduce the "Edge extraction parameter" so that the shape can be imagined from the edge.

By selecting the parameter in the parameter list and clicking the [Change] button, the parameter value can be changed.

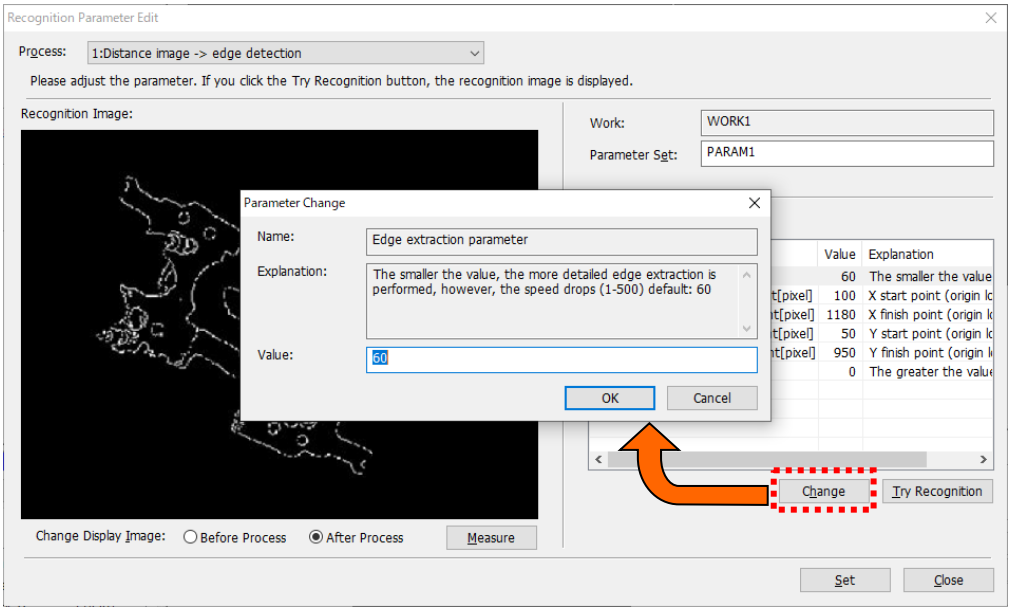


Fig.8-58 Recognition parameter change

By clicking the [Try Recognition] button after changing the parameter value, edge detection processing is performed again. This processing will take a little time. Wait a short while until recognition images are updated.

(b) Edge image → Point group sampling for recognition
Select "2: Edge image → Point group sampling for recognition" from the processing step combo box. The image in which points are sampled from edge image is displayed as the recognition image after processing.

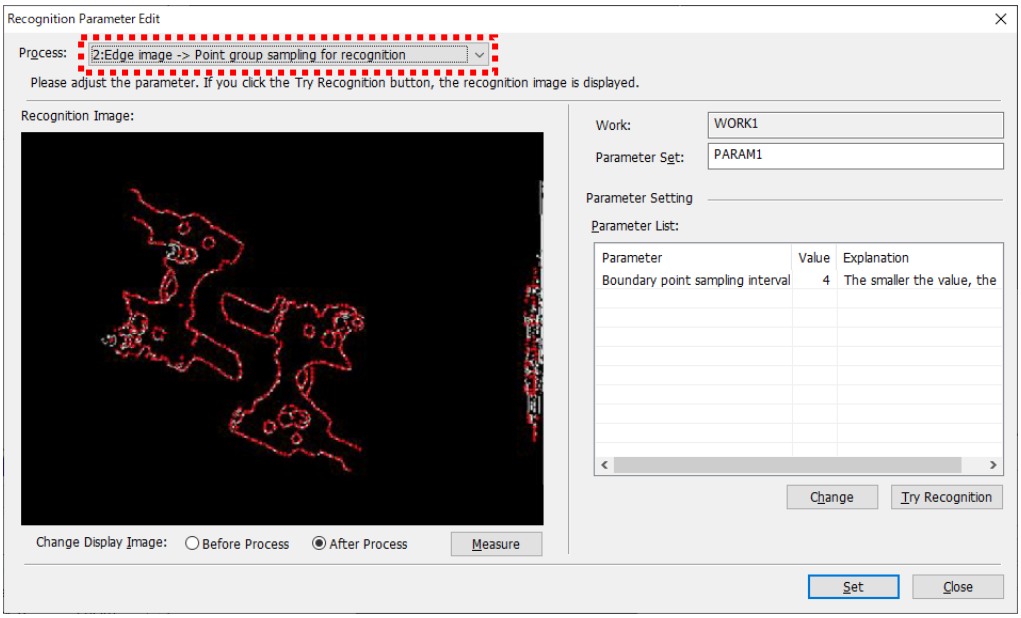


Fig.8-59 Point group sampling for recognition

Table 8-20: Parameter of point group sampling for recognition

Parameter	Unit	Description	Range	Default setting
Boundary point sampling interval	-	The smaller the value, the more characteristics are extracted, however, the speed drops.	1 to 100	4

Check the enlarged image screen for the image after processing to ensure that points are sampled.

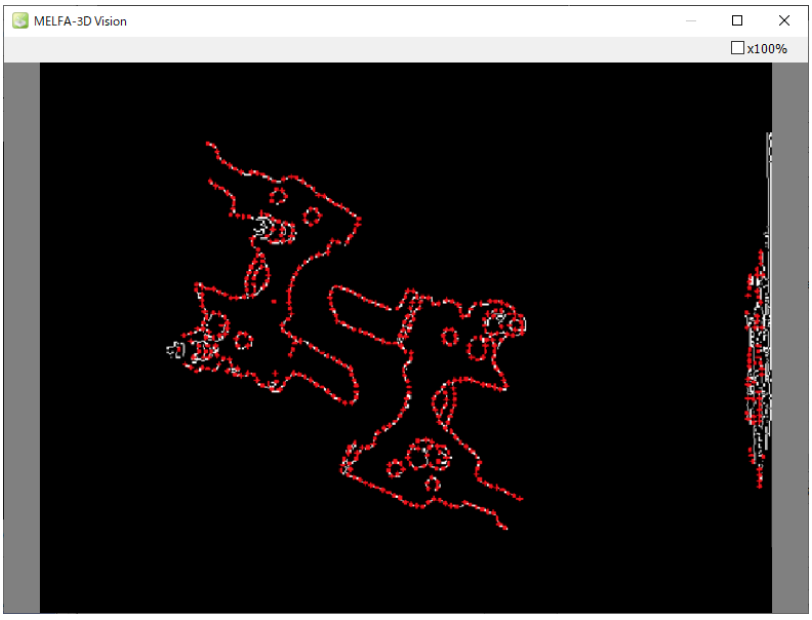


Fig.8-60 Point sampling successful example

(c) Point group → Tangent line detection
Select "3: Point group → Tangent line detection" from the processing step combo box. The image in which tangent lines are detected from the edge point image appears in the recognition image after processing.

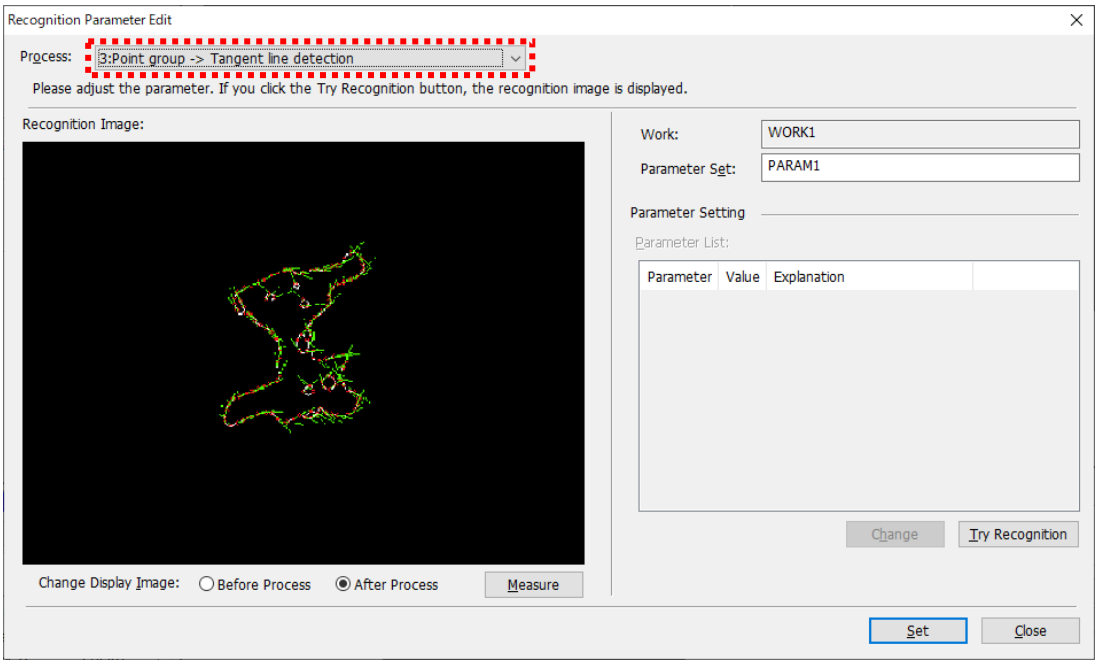


Fig.8-61 Tangent line detection

While displaying the enlarged image screen of the recognition image, confirm that a straight line is detected as in Table 8-21.

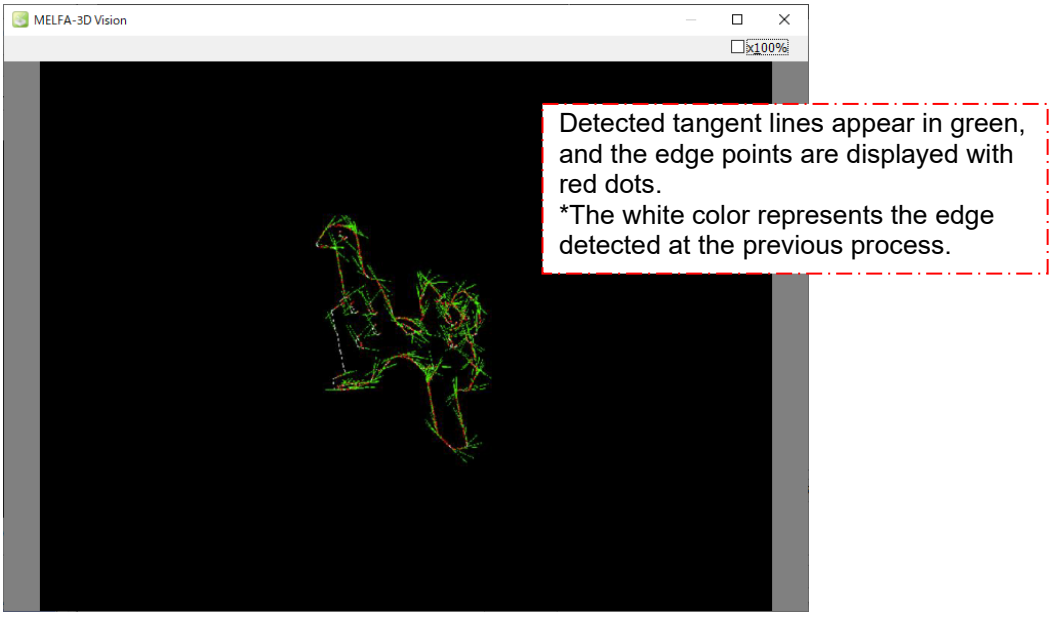


Fig.8-62 Successful example of detected tangent lines

Table 8-21: Items to be confirmed during tangent line detection

No.	Check item	Remedy
1	Is there a significant deviation in the position of the white and green edges?	If so, there is a possibility that XY calibration may have been unsuccessful. Perform XY calibration again.

(d) Recognition processing
Select "4: Recognition processing" from the processing step combo box. The result of recognition processing is displayed as the recognition image after processing. The 3D-CAD model displayed in green is the recognition result.

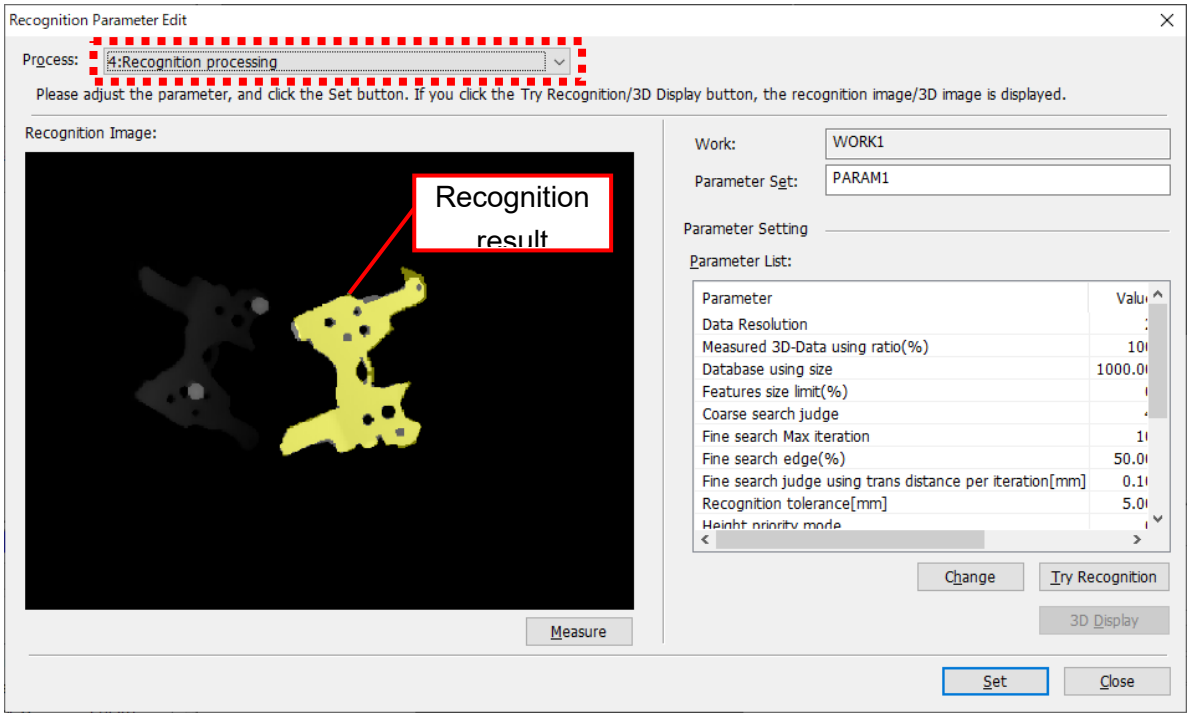


Fig.8-63 Recognition processing

Table 8-22: Parameters for recognition processing

Parameter	Unit	Description	Range	Default setting
Data Resolution	-	Processing is performed after reducing the image to 1/n. The larger the value, processing is performed at high speed, however, accuracy drops.	1, 2	2
Measured 3D-Data using ratio	%	Percentage of measurement data used for features extraction. The larger the value, the more data is used and the more the recognition rate improves, however, the speed drops.	10 to 100	100
Database using size	-	Threshold of features reduction. The smaller the value, the more features are deleted and processing is performed at high speed, however, the recognition rate drops.	50 to 10000	1000
Features size limit	%	The lower limit of the extracted features size. The larger the value, the features of smaller size is not used, and processing is performed at high speed, however, the recognition rate drops.	0 to 100	0
Coase search judge	piece (s)	The smaller the value, the more posture candidates are calculated, however, the speed drops.	3 to 20	4
Fine search Max. iteration	times	If a small value is entered, emphasis is placed on the speed, and if a large value is entered, emphasis placed on accuracy.	1 to 50	10
Fine search edge	%	Parameter to determine how much the contour shape should be considered for detailed positioning of the surface fitting base.	0.00 to 100.00	50.00
Fine search judge using trans distance per iteration	mm	Processing is terminated when the estimated error for translation [mm] is equal to or lowers than the set value.	0.01 to 1.00	0.10
Recofnition tolerance	mm	Set the alignment torelance between the CAD model and 3D scan data.	0.10 to 10.00	5.00
Height priority mode	-	If this parameter is 1, the workpiece in the high position is preferentially recognized.	0: Score priority 1: High priority	0
Workpiece protruding ratio	%	The workpieces that the area that does not protrude from the recognition area is greater than or equal to the specified ratio become the recognition target.	50 to 100	50
Fitting area ratio	%	The workpieces that the area that not hidden by other workpieces is greater than or equal to the specified ratio become the recognition target.	50 to 100	90
Rotationally symmetrical workpiece: Shape	-	Specify the shape of rotationally symmetrical workpiece. (If the cuboid is specified, the rotationally symmetrical axes are x-axis and y-axis.)	0: Irrotational 1: Cylinder 2: Cuboid 3: Square prism	0

Parameter	Unit	Description	Range	Default setting
			4: Regular hexagonal prism	
Rotationally symmetrical workpiece: Axis	-	Specify the rotationally symmetrical axis of the workpiece on the work coordinate system. (If the shape is the irrotational symmetrical or cuboid, the setting of this parameter is ignored.)	0: X-axis 1: Y-axis 2: Z-axis	0
The number of initial candidates	Pieces	Set the number of recognition candidates as initial candidates.	1 to 200	10
The number of recognition result	Pieces	Set the number of recognition candidates to be finally calculated. (This parameter does not affect the recognition time.)	1 to 10	1

Table 8-23: Items to be confirmed during recognition processing

No.	Items to be confirmed	Countermeasure
1	Check that the workpiece is not recognized several times.	When the same workpiece is recognized several times, change the value of the parameter "The number of recognition result" to 1.

Check the enlarged image screen for the recognition image or the 3D display screen displayed by clicking the [3D Display] button to confirm whether the position and posture for the measured workpiece and recognition result match.

Fig.8-64 Recognition processing successful example (2D display)

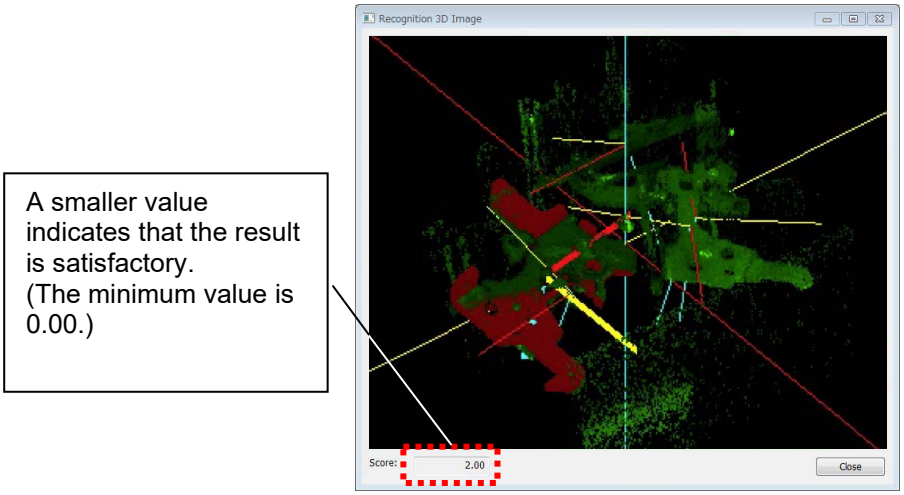


Fig.8-65 Recognition processing successful example (3D display)

If the recognition time and results are acceptable, click the [Set] button to finish the model-less recognition parameter settings. If wishing to change the parameter set name, change the parameter set field and then click the [Set] button.

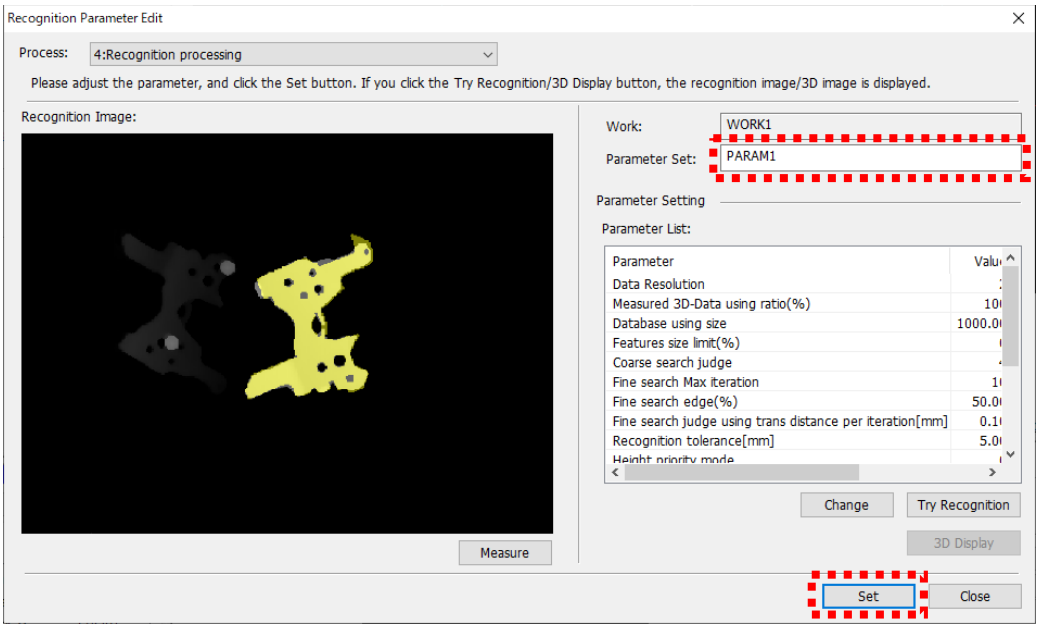


Fig.8-66 Parameter set setting

■ Workpiece list registration

The following screen is used to create a workpiece list (Table 8-14). Click the [Register Work List] button, and then click the [Add] button at on the left of the Workpiece list registration screen that appears. A workpiece list name Note 1 entry screen appears. Enter an arbitrary workpiece list name and click the [OK] button.

Note 1: Up to 32 single-byte alphanumeric characters

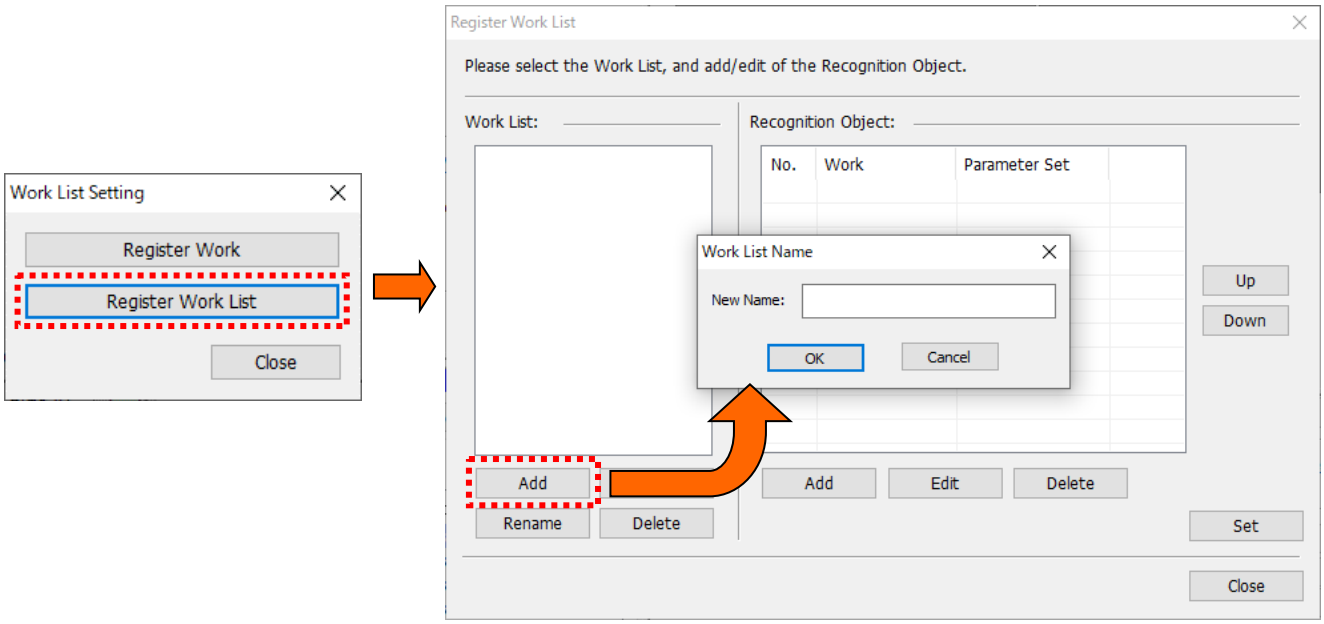


Fig.8-67 Workpiece list registration

By then clicking the [Add] button on the right of the Workpiece list registration screen, a Recognition target addition screen appears. Select the workpiece and parameter set combination from the drop-down list, and then click the [OK] button. By repeating this process, a list of recognition targets to be registered in the workpiece is created.

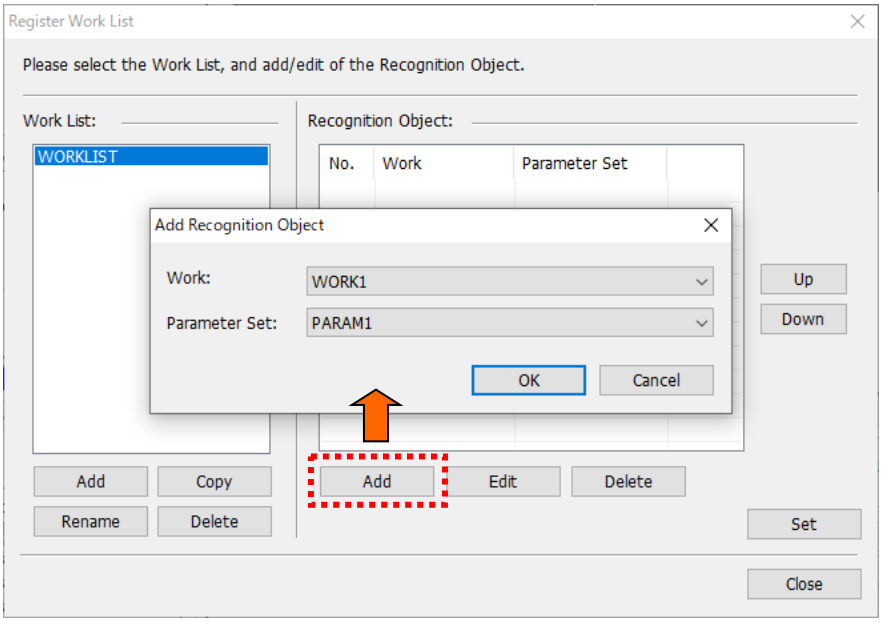


Fig.8-68 Recognition target addition

By clicking the [Set] button, the created workpiece list is registered.

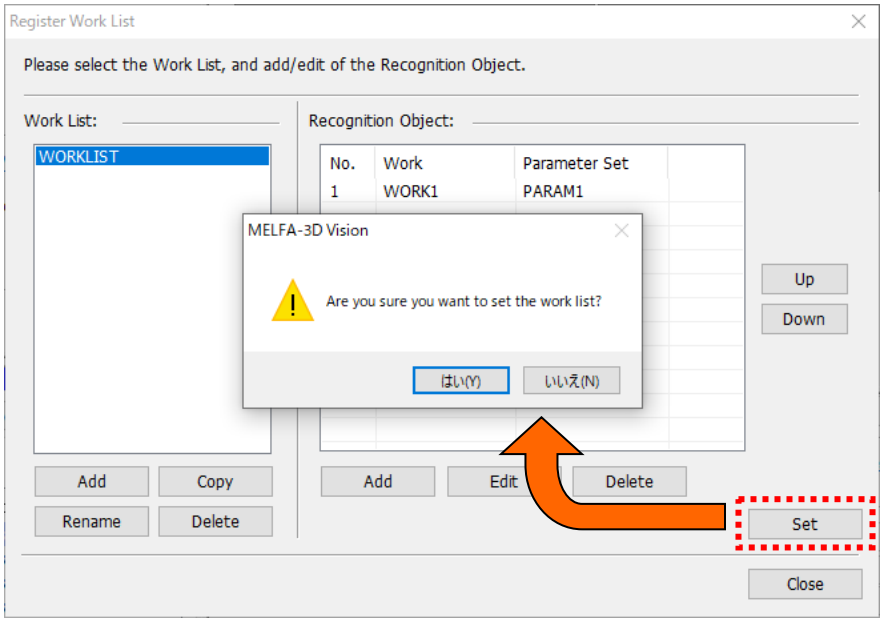


Fig.8-69 Recognition target list

If changing the list order, select the row for the list No. to be changed from the list, and move the row by clicking the [Up] and [Down] buttons.

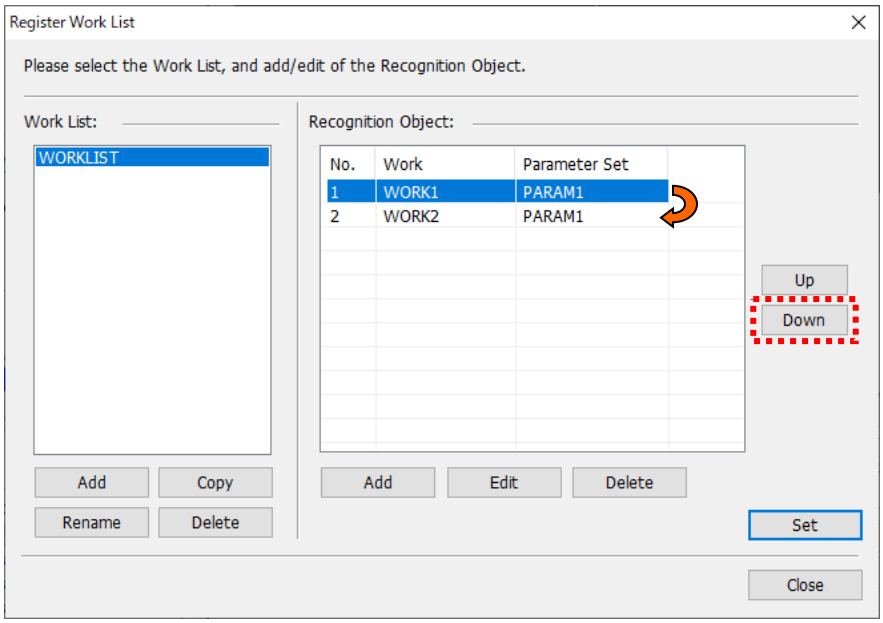
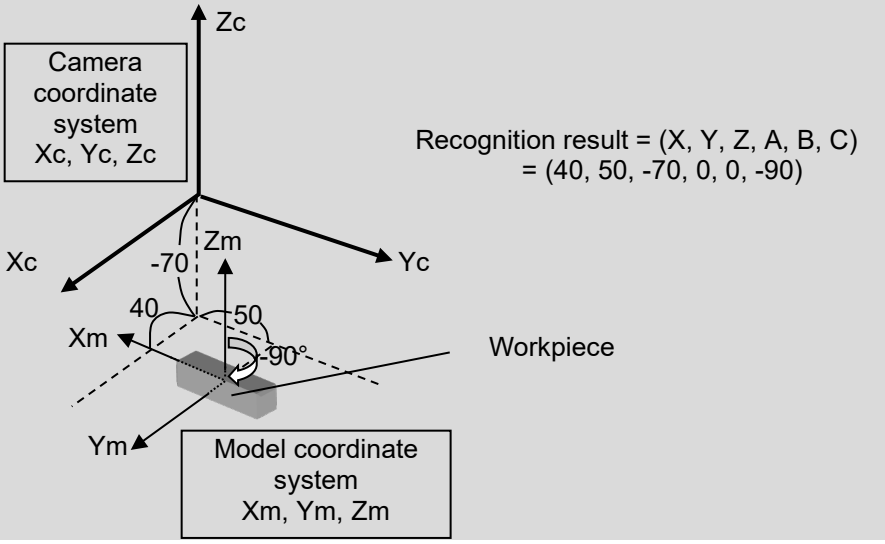


Fig.8-70 List order change

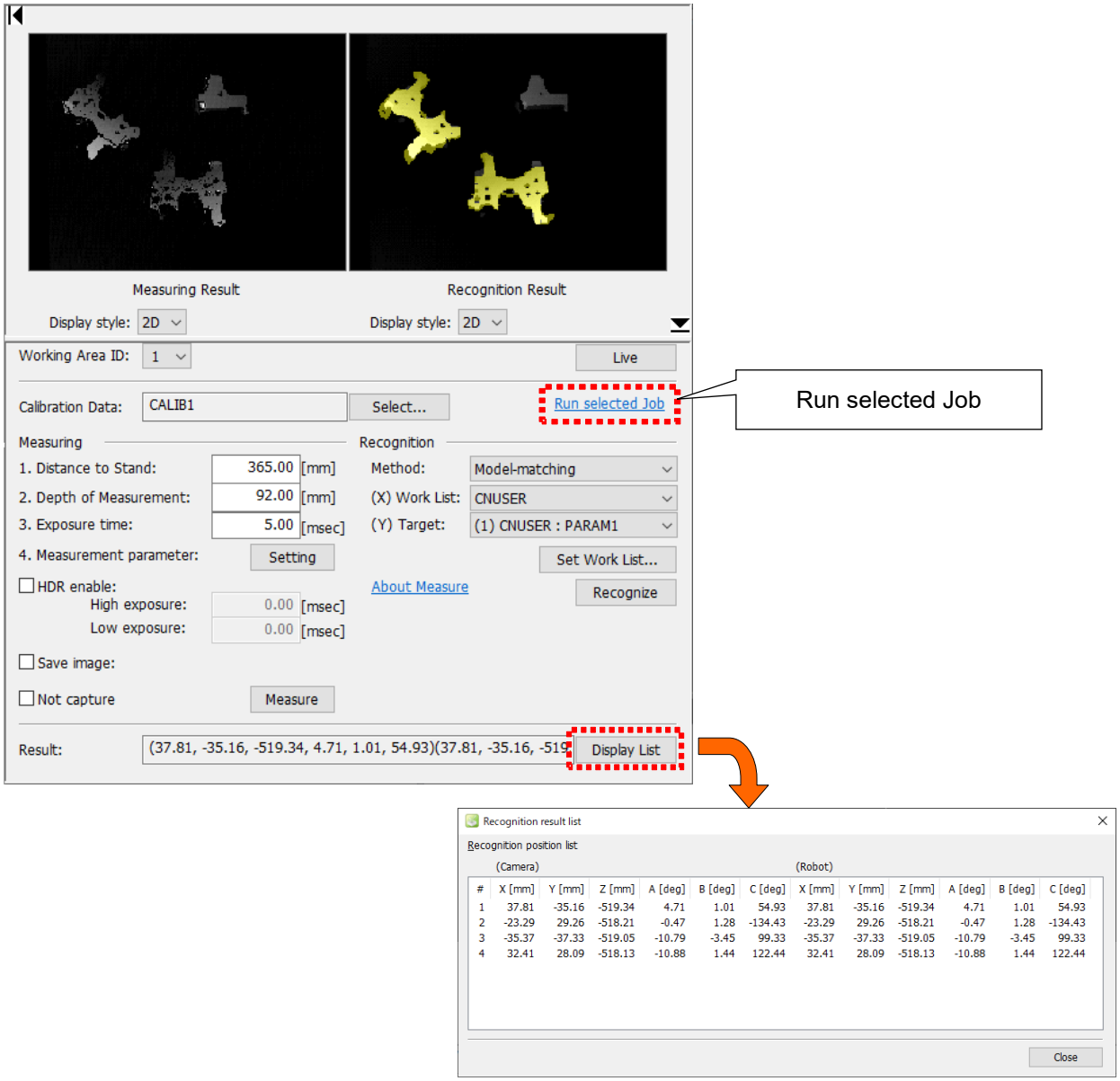
■ Checking the recognition results
Change the position of the workpiece in the measurement range, or increase the number of workpieces. Click the [Measure] button to perform measurement. Then, select the workpiece list and the recognition target, and click the [Recognize] button. The recognition result with the best score from the recognized workpieces appears in the result field, and the image is displayed in green in the Recognition result screen. The recognition result is the model coordinate system position and posture viewed from the camera coordinate system (see 2.4.4 Camera coordinate system).

By clicking the [Display List] button, other recognition results can also be viewed. Please note that the results are displayed in the list in order from the higher score.

◇◆◇Recognition result◇◆◇
The recognition results of X, Y, and Z components represent the model coordinate system origins, and the A, B, and C components represent the model coordinate system posture (rotation around Z-axis → around Y-axis → X-axis in this order) against the camera coordinate system.



◇◆◇Workpiece list and recognition target◇◆◇
The workpiece list specified here is saved to the job. The recognition target is specified with the V3Run command (see 12.1) when executed with the robot program.



For the camera coordinates, refer to "2.4.4 Camera coordinate system".
For the robot coordinates, refer to the instruction manual "Detailed explanations of functions and operations".

Fig.8-71 Checking the recognition results

Click the [Run selected Job] link and proceed to the job execution after the adjustment.

8.3.3. Job Execution

By clicking the [Run] button in the Job execution screen, the created job can be executed. Measurement and recognition are only performed when the [Run] button is clicked if the respective check boxes adjacent to the measurement and recognition items are selected. If, for example, the recognition check box is cleared and only the measurement check box is selected, only measurement will be performed when the [Run] button is clicked. If, however, performing recognition only, it is necessary that measurement data is entered beforehand in the specified workspace ID.

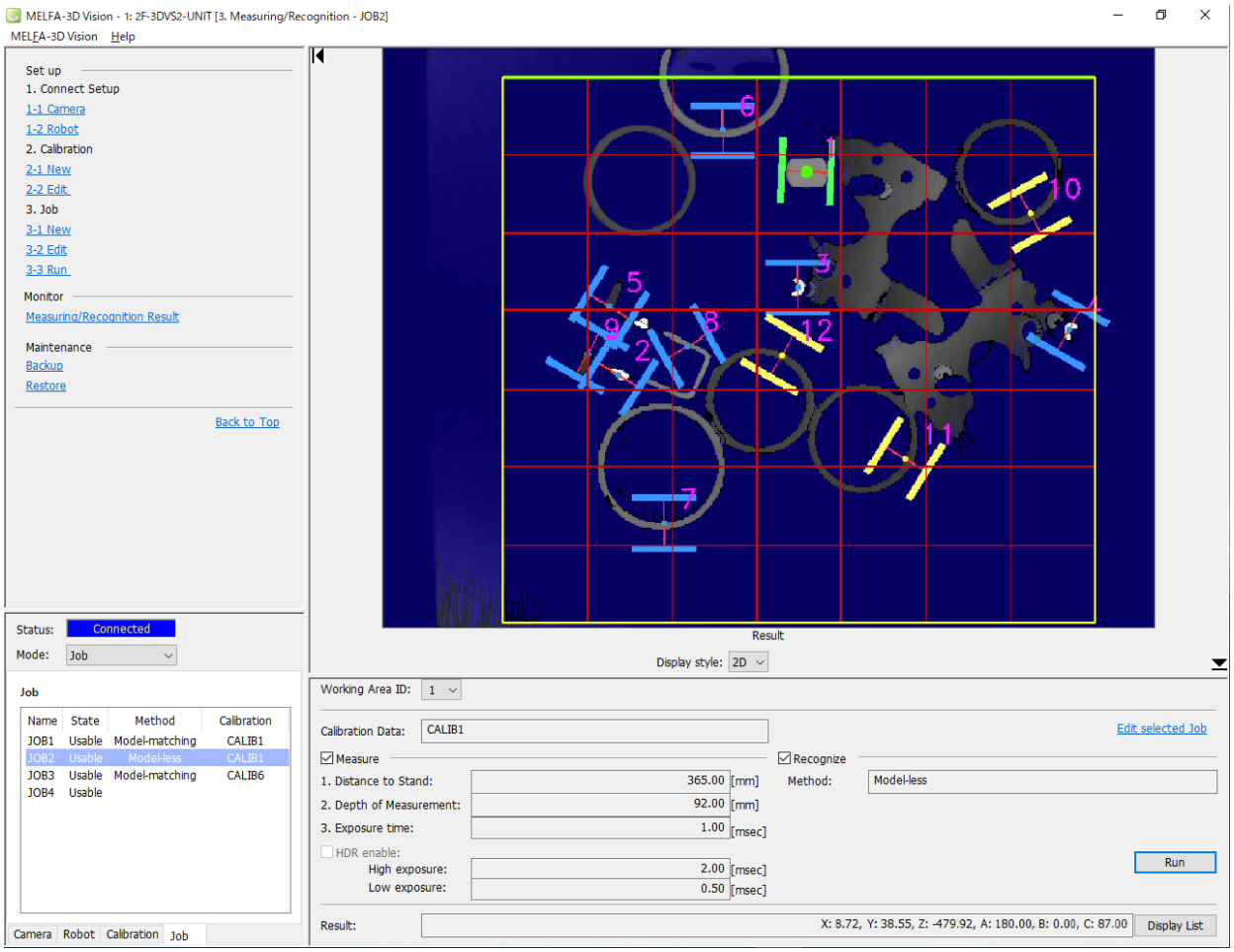
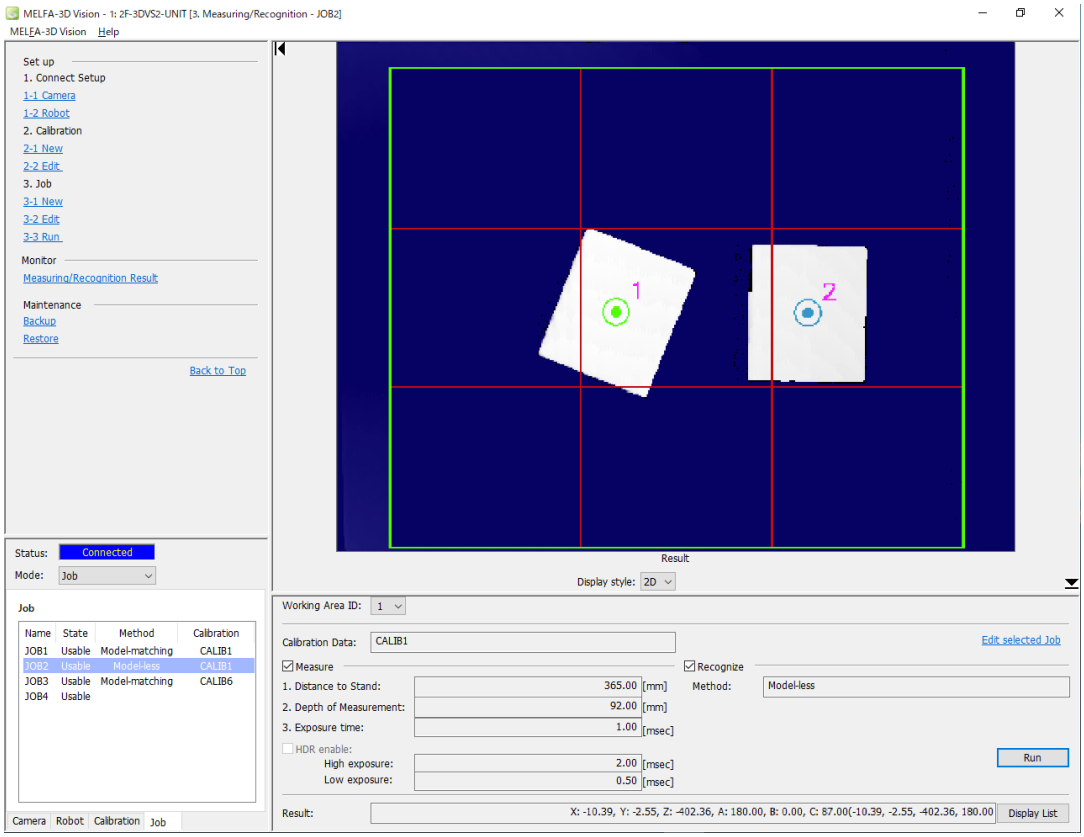
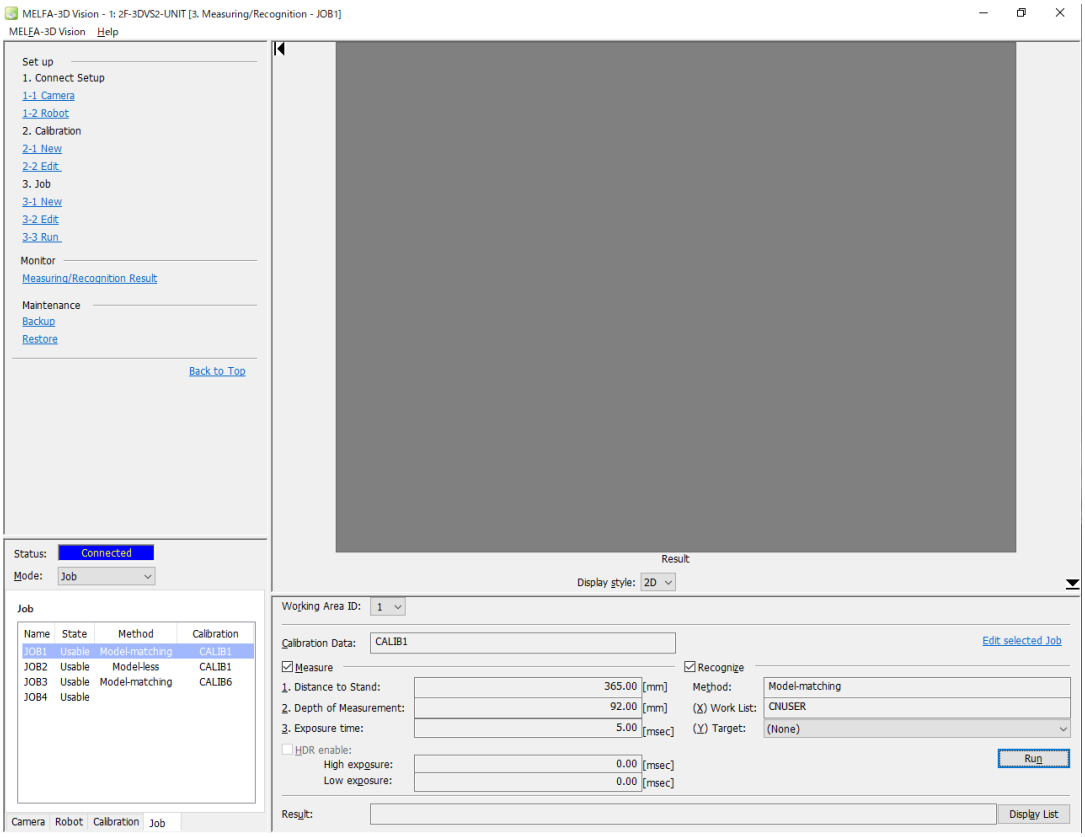


Fig.8-72 Confirmation of recognition results

To check the existing job to see how it works, click [3. Job] → [3-3 Run] in the guidance menu. The Select Job screen will appear. Select the job to display the job execution screen.



Model-less recognition



Model matching recognition

Fig.8-73 Existing job execution

8.4. Editing and deleting jobs

■ Editing existing jobs
To edit the existing job, click [3. Job] → [3-2 Edit] in the guidance menu. The Select Job screen will appear. Select the job you want to edit, then click the [Select] button.
For each item on the Select Job screen, refer to "Table 6-5: Information displayed on the properties monitor (job)

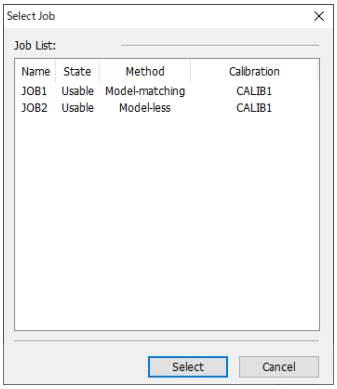


Fig.8-74 Job selection

■ Changing the job name
If changing the job name, select the job tab in the Properties window, right-click the applicable job name, and then click [Rename] in the context menu that appears to change the name.

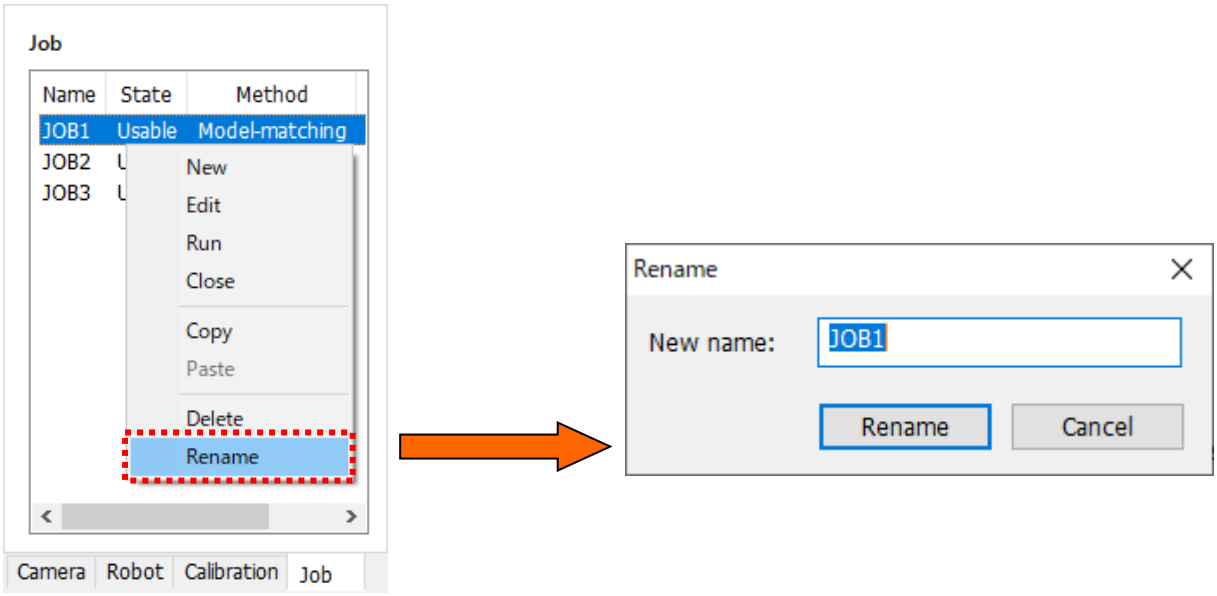


Fig.8-75 Changing the job name

■ Deleting jobs
To delete a job, click [Delete] in the context menu. However, jobs that are being edited cannot be deleted. To close the Edit screen, click [MELFA-3D Vision] - [Close job] on the menu bar.

9. Picking

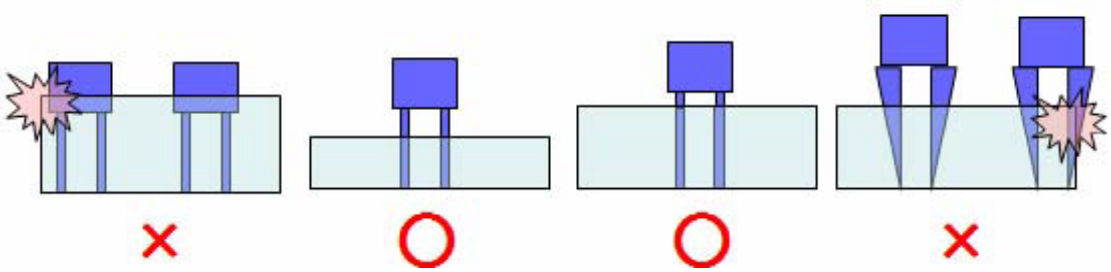
9.1. Checking Interference with Surrounding Objects

Check the external dimensions of the camera (refer to "3.2 Items to be Prepared by Customer") and perform operation while fully considering the hand size and preventing interference with surrounding objects.
Before actual operation, make sure that picking is performed without interfering with surrounding objects.

9.2. Hand claw shape

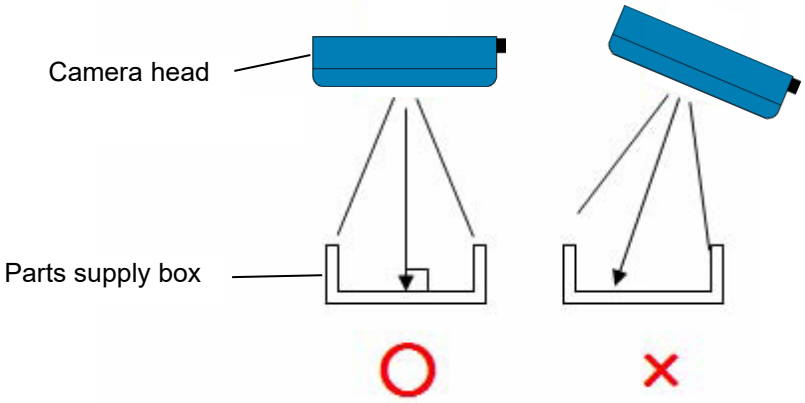
When using model-less recognition, it is necessary to pay attention to the following points when designing the hand claw in order to avoid interference with the parts supply box as shown in the above drawing.

- The claw should be longer than the height of the parts supply box.
- The claw thickness should be uniform.

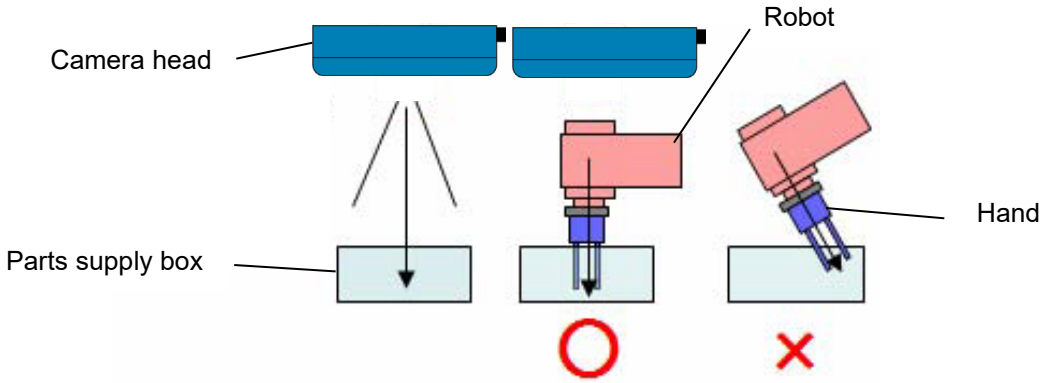


If the claw is longer than the height of the parts supply box, the upper part of the hand will not interfere with the box, however, if the claw thickness is not uniform as shown in the drawing in the upper right, the upper portion of the claw may interfere with the box when picking parts from the edge of the box. It is therefore necessary to make adjustments to avoid claw and parts supply box interference by making the claw thickness uniform, or by setting a recognition area sufficiently away from the wall of the parts supply box.
Interference can also be avoided by setting the recognition range parameters (shown in Table 8-11 for model-less recognition and Table 8-18 for model-matching) so that the recognized area is smaller than the parts supply box.

9.3. Camera head installation method for model-less recognition



Make the camera head's line of sight direction (direction viewed by camera) perpendicular to the bottom of the parts supply box. As shown in the drawing above, if the bottom and the line of sight direction are not perpendicular to one another, workpiece recognition may fail, resulting in collision of the hand claw with the bottom, or malfunction of the residual amount detection.



Furthermore, if the hand entry direction to perform the take-out operation does not match the 3D camera's line of sight direction as shown in the drawing in the above right, the hand may collide with the parts supply box. Therefore, align the hand entry direction for picking with the line of sight direction.

9.4. Tool settings

For tool settings, perform setting of the X, Y, and Z components first, and then the A, B, and C component. The setting procedure is as follows. For details of general information on tools, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

9.4.1. Setting the X, Y, and Z components

Set using the "Tool automatic calculation function". The "Tool automatic calculation function" is used to automatically calculate the tool length by teaching the same points in three to eight points against the position to be set as a control point, allowing the tool parameter (MEXTL) value to be set.

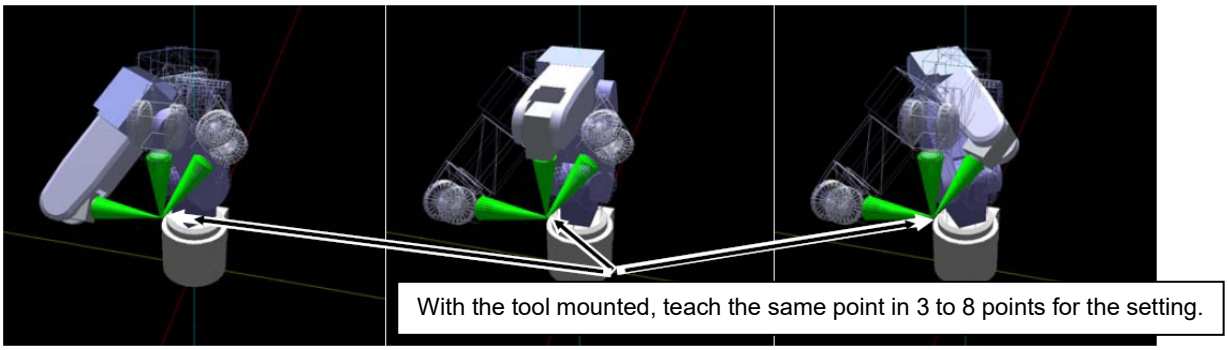


Fig. 9-1 Tool automatic calculation overview

The tool automatic calculation function is used with RT ToolBox3 connected to the robot controller. Select [Tool] for the applicable project from the project tree, and then double-click [Tool automatic calculation].

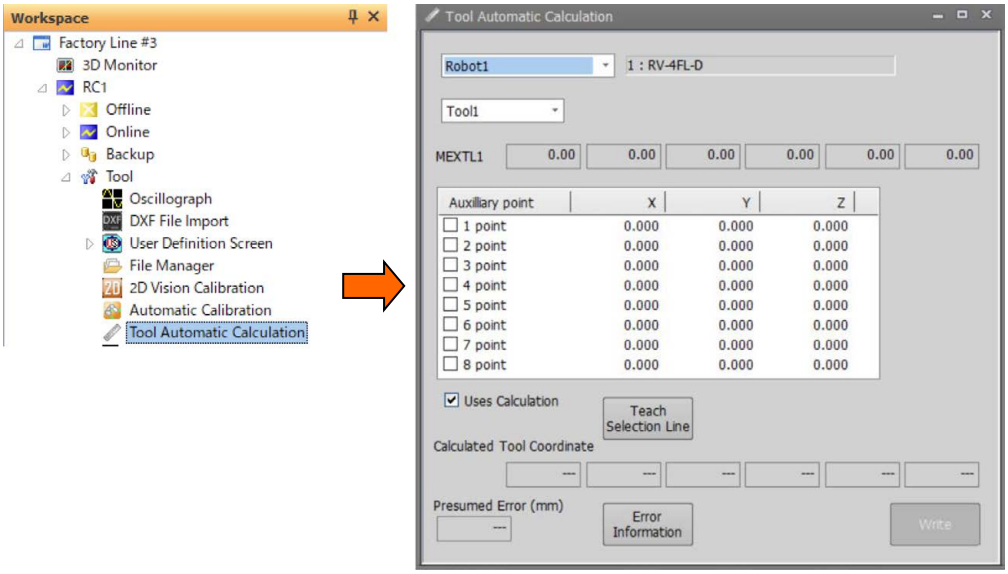


Fig. 9-2 Starting tool automatic calculation

Perform tool automatic calculation using the following procedure.

1. Select the target robot <a> and the tool number <b>.
2. Move the robot with the tool mounted. After selecting the line of "Auxiliary point list" <c>, click the [Teach selection line] button <d>. Teach the same position in three points or more from different postures against the position to be set as a control point.
3. By clicking the [Error information] button <f>, it is possible to check the presumed error of the calculated tool length. If the presumed error does not lie within the permissible range, return to 2. and increase the number of auxiliary points used for calculation.
4. When a value is set to the "Calculated tool coordinate", the [Write] button <e> becomes active. By clicking the [Write] button <e>, the tool parameter (MEXTL) is written to the robot controller.

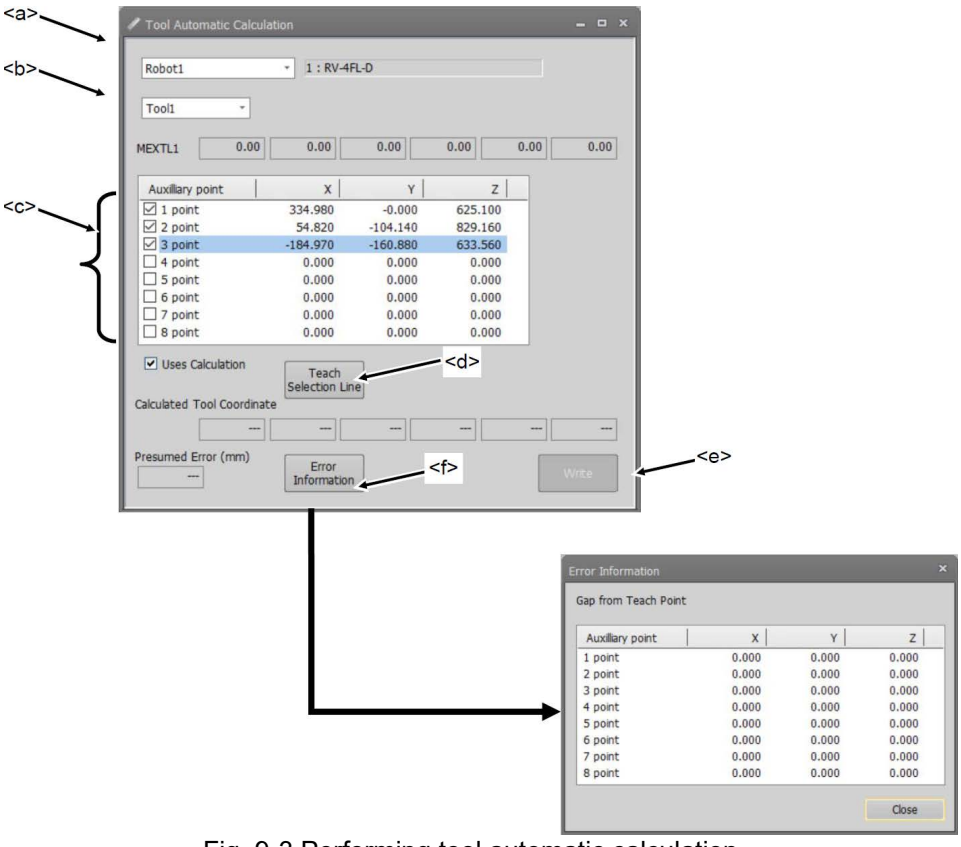
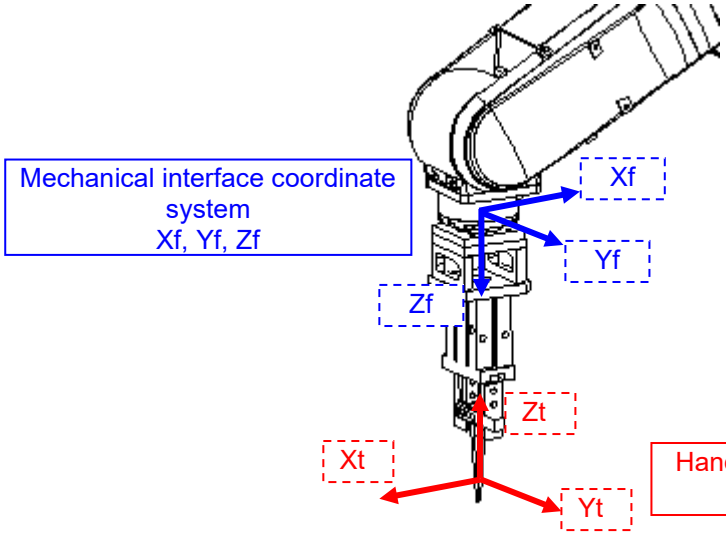


Fig. 9-3 Performing tool automatic calculation

◇◆◇Teaching points◇◆◇
- Teach the position by greatly changing the posture of the robot. If similar postures are used (only the A axis differs, for example), the tool coordinate may not be calculated.
- For model-less recognition, teach the same point against the origin of the hand coordinate system.

9.4.2. Setting the A, B, and C components



In the example shown on the left where the Z-axis direction is inverted, by setting the A, B, and C components of the tool as shown below, the tool coordinate system and hand coordinate system posture match.

(A, B, C) = (0, -180, 0)

Fig. 9-4 Tool A, B, and C component setting example

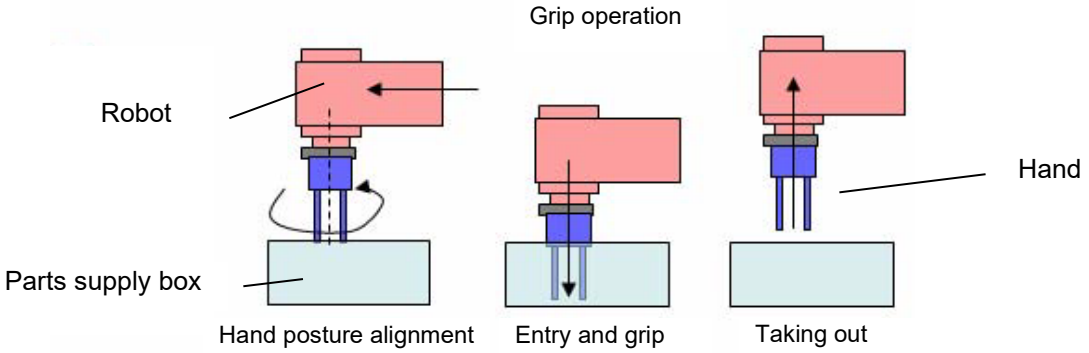
◇◆◇When model-less recognition is used◇◆◇
•Based on the value set for the recognition parameter posture output mode, the Z-axis direction of the hand coordinates system matches the Z-axis direction of the mechanical interface coordinates system. (Refer to Table 8-11: Recognition parameters)

Caution

It should be noted that by setting the A, B, and C components, the Z-axis direction is reversed from the tool coordinate default value. Therefore, the approach distance and pullout distance (Mvs only) direction specified with Mov and Mvs will also change.

9.5. Creating robot programs

9.5.1. Model-less recognition



To perform picking, control the robot in three separate phases as shown below.

1. Align the hand posture (hand posture alignment) by the time it moves over the parts supply box.
2. Move the hand perpendicularly to the floor (entry and gripping).
3. After picking, move the hand in the direction opposite to the entry direction (taking-out operation).

If the hand approaches the parts supply box during position alignment, the hand may interfere with surrounding workpieces in the course of entry and displace positions of the workpieces, resulting in unsuccessful picking. Therefore, by moving the hand to enter the box from the line of sight direction, minimum interference with workpieces is assured to achieve stable picking.

A sample program is shown below.

9.5.1.1. Bulk picking using hand eye

■ Operation details

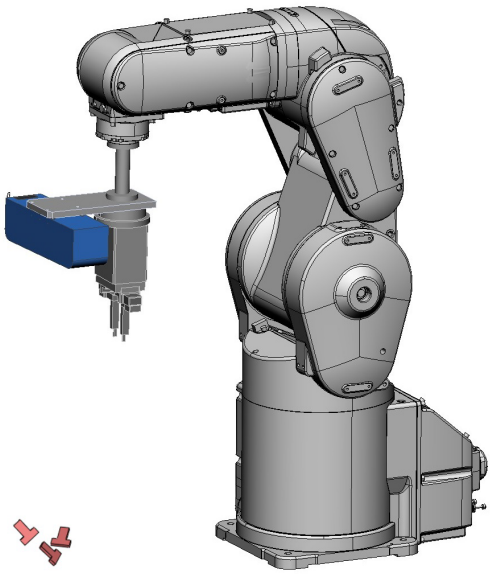
Gripping and delivery of bulk loaded workpieces

- The hand moves to the measurement position, JOB 1 is executed for measurement and recognition.
- The hand moves to the hand posture alignment position.
- The hand moves to the workpiece grip position and grips the workpiece.
- The workpiece is taken out.
- The workpiece is delivered.

⚠ Caution

Since checking of interference with surrounding objects when gripping a workpiece is not performed, load workpieces in bulk on a flat surface without using a parts supply box when the posture output mode 2, 4, 5, or 6 is selected.

Before starting automatic operation, make sure that there are no obstacles in the surroundings. Be aware of the override speed.
If communication cannot be established properly among the camera, robot, and control unit, automatic operation may stop.



■ Program example <Sample Program JMLH.prg>
This program is for the RV-F/RV-FR series.
When using the program in the RH-FH/RH-FRH series, refer to Note 3.

```
'[Connection to MELFA-3D Vision]
If M_Open(1) <> 2 Then                          'If vision sensor No. 1 is not capable of measurement
   V3Open "COM2:" As #1                         'Connect to vision sensor connected to COM2:, and set number to 1.
EndIf
Wait M_Open(1) = 2                              'Connect to vision sensor No. 1 and wait until measurement is possible.
'[Measurement and recognition]
*CapAndRecg
Mov PCap                                        'Move to measurement position (position shown in drawing above).
Dly 1                                           'Wait for robot tip vibrations to subside.
V3Run #1,"JOB1", 1, 1, 1, 1, 1                  'Execute "JOB1" Note 1.
*Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1      'Wait until result received from MELFA-3D Vision.
If M_V3Rslt(1) <> 0 Then Error 9100             'Output error 9100 if unsuccessful.
MNum = M_V3Num(1)                               'Store recognition count in MNum.
If MNum = 0 Then Goto *FIN                      'Recognition count is 0 and therefore finished.
PRcg = P_V3Pos(1, 1)                            'Recognition result acquisition Note 2
'[Hand posture alignment position and workpiece grip position calculation]
PRot = P_Zero
If Deg(PRcg.C)>+90 Then PHnd.C = -180DEG        'Corrected value to prevent camera head collision Note 2
If Deg(PRcg.C)<-90 Then PHnd.C = +180DEG        'Corrected value to prevent camera head collision Note 2
'------------ Hand posture alignment position calculation ----------
PAp = PRcg
PAp.Z = 150                                     'Substitute the height of space above the part supply box.
PAp = PAp * PHnd                                'Calculate the alignment position of hand postures.
If Deg(PRcg.A)>+0 And Deg(PRcg.A)<+135 Then PAp.A = +135DEG 'Correction to prevent peripheral
                                                             interference Note 3
If Deg(PRcg.A)<-0 And Deg(PRcg.A)>-135 Then PAp.A = -135DEG  'Correction to prevent peripheral
                                                             interference Note 3
If Deg(PRcg.B)>+45 Then PAp.B = +45DEG          'Correction to prevent peripheral interference Note 3
If Deg(PRcg.B)<-45 Then PAp.B = -45DEG          'Correction to prevent peripheral interference Note 3
'------------ Entry/grip position calculation ----------
PGet = PAp
```

```
PGet.Z = PRcg.Z - 20                    'PRcg.Z is the position on top of the workpiece, and
                                        therefore the amount of claw penetration is subtracted Note 4.
'[Move to hand posture alignment position and workpiece grip position, and grip workpiece]
Mvs PAp                                 '(1) Hand posture alignment
Mvs PGet                                '(2) Entry, grip
Dly 0.5
HClose 1
Dly 0.5
Mvs PAp                                 '(3) Taking out
'[Move to workpiece delivery position, and deliver workpiece]
Mov PRel
Dly 0.5
HOpen 1
Dly 0.5
GoTo *CapAndRecg
'
*FIN
V3Close #1                              'Disconnect from vision sensor connected to COM2.
Hlt
End
```

Note 1: The camera installation type set in the calibration data must be "Hand".
Note 2: Indicates the correction value to prevent the camera head from colliding with the robot arm. The correction value differs depending on the relationship between the camera and hand postures or measurement posture.
Note 3: When using the RH-FH/RH-FRH series robot, change these four lines into comments.
Note 4: Set the thrust amount to roughly three fourths of the workpiece height.

9.5.1.2. Bulk picking using fixed camera

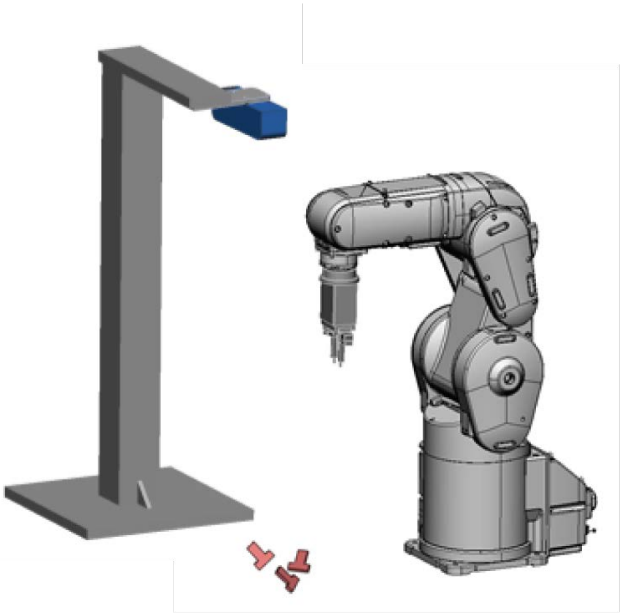
■ Operation details

Gripping and delivery of bulk loaded workpieces

- The robot moves to the escape position.
- JOB1 is executed for measurement and recognition.
- The hand moves to the hand posture alignment position.
- The hand moves to the workpiece grip position and grips.
- The workpiece is taken out.
- The workpiece is delivered.

⚠ Caution

Since checking of interference with surrounding objects when gripping a workpiece is not performed, load workpieces in bulk on a flat surface without using a parts supply box when the posture output mode 2, 4, 5, or 6 is selected.



■ Program example <Sample Program JMLF.prg>
*This program is for the RV-F/RV-FR series.
When using the program in the RH-FH/RH-FRH series, refer to Note 2.

```
'[Connection to MELFA-3D Vision]
If M_Open(1) <> 2 Then                          'If vision sensor No. 1 is not capable of measurement
   V3Open "COM2:" As #1                         'Connect to vision sensor connected to COM2: and set number to 1.
EndIf
Wait M_Open(1) = 2                              'Connect to vision sensor No. 1 and wait until measurement is possible.
While 1
   '[Measurement, recognition]
   Mov PEva                                     'Move to escape position.
   V3Run #1,"JOB2", 1, 1, 1, 1, 1               'Execute "JOB2" Note 1.
   *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1   'Wait until result received from MELFA-3D Vision.
   If M_V3Rslt(1) <> 0 Then Error 9100          'Output error 9100 if unsuccessful.
   MNum = M_V3Num(1)                            'Store recognition count in MNum.
   If MNum = 0 Then Goto *FIN                   'Recognition count is 0 and therefore finished.
   PRcg = P_V3Pos(1, 1)                         'Recognition result acquisition Note 2
   '[Hand posture alignment position and workpiece grip position calculation]
   '------------ Hand posture alignment position calculation ----------
   PAp = PRcg
   PAp.Z = 150                                  'Substitute the height of space above the part supply box.
   If Deg(PRcg.A)>+0 And Deg(PRcg.A)<+135 Then PAp.A = +135DEG    'Correction to prevent peripheral
                                                                  interference Note 2
   If Deg(PRcg.A)<-0 And Deg(PRcg.A)>-135 Then PAp.A = -135DEG    'Correction to prevent peripheral
                                                                  interference Note 2
   If Deg(PRcg.B)>+45 Then PAp.B = +45DEG       'Correction to prevent peripheral interference Note 2
   If Deg(PRcg.B)<-45 Then PAp.B = -45DEG       'Correction to prevent peripheral interference Note 2
   '------------ Entry/grip position calculation ----------
   PGet = PAp
   PGet.Z = PRcg.Z - 20                         'PRcg.Z is the position on top of the workpiece, and
                                                therefore the amount of claw penetration is subtracted Note 3.
   '[Move to hand posture alignment position and workpiece grip position, and grip workpiece]
   Mvs PAp                                      '(1) Hand posture alignment
   Mvs PGet                                     '(2) Entry, grip
```

```
   Dly 0.5
   HClose 1
   Dly 0.5
   Mvs PAp                                          '(3) Taking out
   '[Move to workpiece delivery position, and deliver the workpiece]
   Mov PRel
   Dly 0.5
   HOpen 1
   Dly 0.5
   Mvs PAp
WEnd
'
*FIN
V3Close #1                                          'Disconnect from vision sensor connected to COM2.
Hlt
End
```

Note 1: The camera installation type set in the calibration data must be "Fixed".
Note 2: When using the RH-FH/RH-FRH series robot, change these four lines into comments.
Note 3: Set the thrust amount to roughly three fourths of the workpiece height.

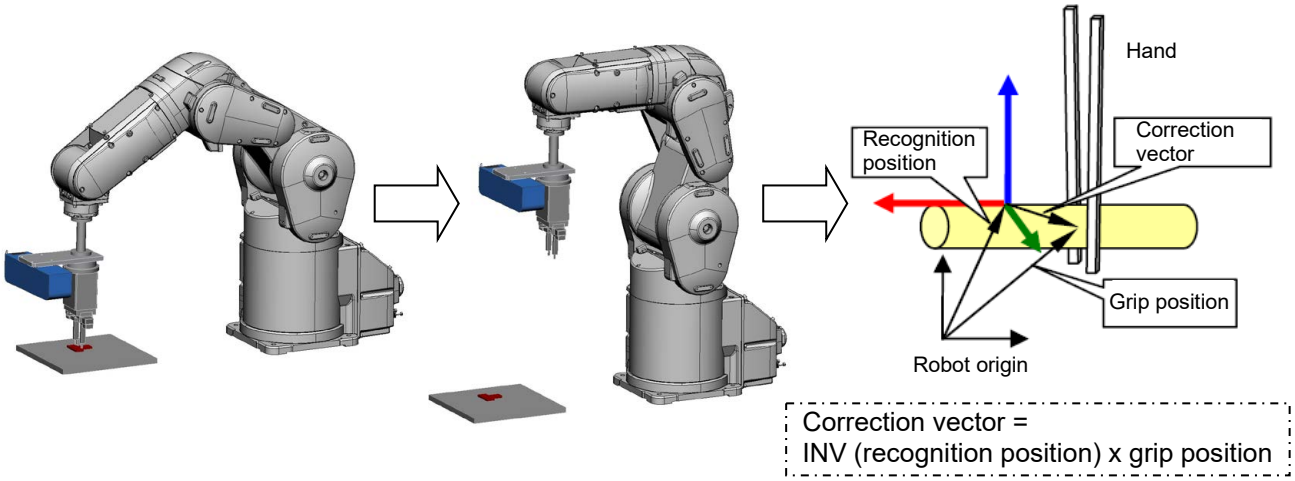
9.5.2. Model matching recognition

9.5.2.1. Grip posture teaching

The workpiece recognition position and the grip position for model matching recognition are different. Therefore, it is necessary to calculate a correction vector to correct the deviation beforehand. The correction vector calculation method is described below.

Model matching recognition is available only for RV series.

1. Obtain the grip position by moving the hand claw or the suction pad to the intended workpiece grip position.
2. Obtain the recognition position by moving the hand to the measurement position and performing workpiece measurement and recognition.
3. Calculate the correction vector by multiplying INV (recognition position) by the grip position.



1. Move to the grip position and perform teaching.
2. Move to the measurement position and perform recognition.
3. Calculate the correction vector.

Fig. 9-5 Correction vector calculation

It should be noted that the workpiece has various postures such as facing sideways or reversed. Therefore, there is a position in which the workpiece can be gripped easily for each posture, even if the workpiece itself is the same. Consequently, it is necessary to find the correction vector from the grip position corresponding to the recognition position at each posture. Therefore, repeat the steps (a) to (c) shown below to calculate the correction vector for each stable workpiece posture.

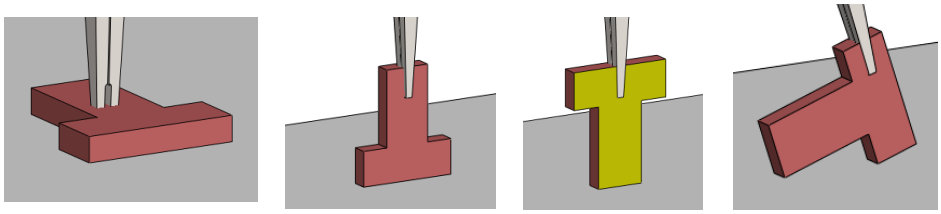


Fig. 9-6 Correction vector calculation

Please note that correction vectors can be calculated using sample program JMMP.prg contained in the provided CD-ROM.

(a) Teach the measurement position (PCap) and then execute sample program JMMP.prg.
Connect to MELFA-3D Vision and then stop at the temporary stoppage line.

(b) Place the workpiece in the measurable area, jog the robot to move the hand claw or the suction pad to the grip position, and then teach the current position to PG_CATCH(n).

◇◆◇Teaching precautions◇◆◇
Perform PG_CATCH(n) teaching as follows so that the program execution line does not return to the beginning.
[R3xTB] Perform teaching in the position editing screen and then save.
[RT ToolBox3] Perform teaching, clear the command line check box at the write items for saving of the program, and then save.
[R5xTB] Perform teaching in the position editing screen, and then save without changing the program.

(c) Execute sample program JMMP.prg. By doing so, the robot moves to the measurement position, and after performing workpiece measurement and recognition, the correction vector (PMAT(n)) is calculated by multiplying INV (recognition position) by the grip position.
Change the workpiece posture and repeat (b) and (c) for the number of possible postures.

■ Program example <Sample Program JMMP.prg>

```
'[Arrangement declaration]
Dim PMAT(10)                    'Correction vector * Change number of elements based on number of grip positions.
Dim PG_CATCH(10)                'Grip position * Change number of elements based on number of grip positions.
'[Connection to MELFA-3D Vision]
If M_Open(1) <> 2 Then          'If vision sensor No. 1 is not capable of measurement
   V3Open "COM2:" As #1         'Connect to vision sensor connected to COM2: and set number to 1.
EndIf
Wait M_Open(1) = 2              'Connect to vision sensor No. 1 and wait until measurement is possible.
'[Correction vector calculation]
For MNO = 1 To 10               'Loop for the number of grip positions to be taught.
   Hlt                          'Temporary stop
   Mov PCap                     'Move to measurement position.
   Dly 1                        'Wait for robot tip vibrations to subside.
   V3Run #1,"JOB1", 1, 1, 1, 1, 1   'Execute "JOB1"
   *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1    'Wait until result received from MELFA-3D Vision.
   If M_V3Rslt(1) <> 0 Then Error 9100           'Output error 9100 if unsuccessful.
   MNum = M_V3Num(1)            'Store recognition count in MNum.
   If MNum = 0 Then Goto *FIN   'Recognition count is 0 and therefore finished.
   PVSDATA = P_V3Pos(1, 1)
   PMAT(MNO) = Inv(PVSDATA) * PG_CATCH(MNO)  'Correction vector calculation
Next
'
*FIN
V3Close #1                      'Disconnect from vision sensor connected to COM2.
Hlt
End
```

9.5.2.2. Picking

Perform picking by the following procedure using the correction vector calculated beforehand.

1. Move to the measurement position, perform workpiece measurement and recognition, and obtain the recognition position.
2. Use the correction vector (N) to calculate all grip position candidates (N) based on the recognition position.
   Grip position candidates (N) = grip position x correction vector (N)
3. Compare the teaching grip position (N) and the grip position candidate (N) according to the following conditions, and then select the execution grip position.
   <Selection conditions>
   • Within operating range • Smallest difference in angle between teaching grip position postures
   • Within permissible gripping angle
4. Move to the execution grip position and grip the workpiece.

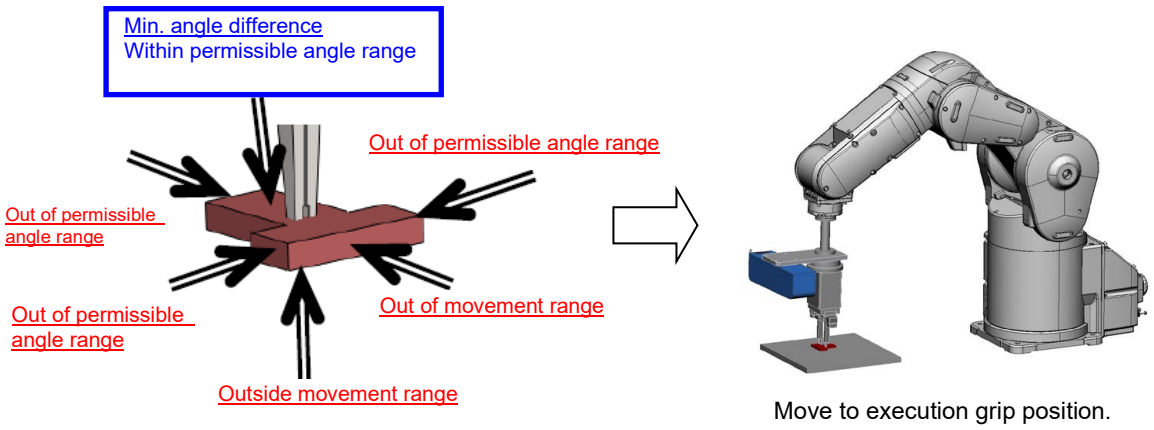


Fig. 9-7 Movement to where the robot grasps a workpiece

A sample program is shown below.

9.5.2.3. Random picking

■ Operation details

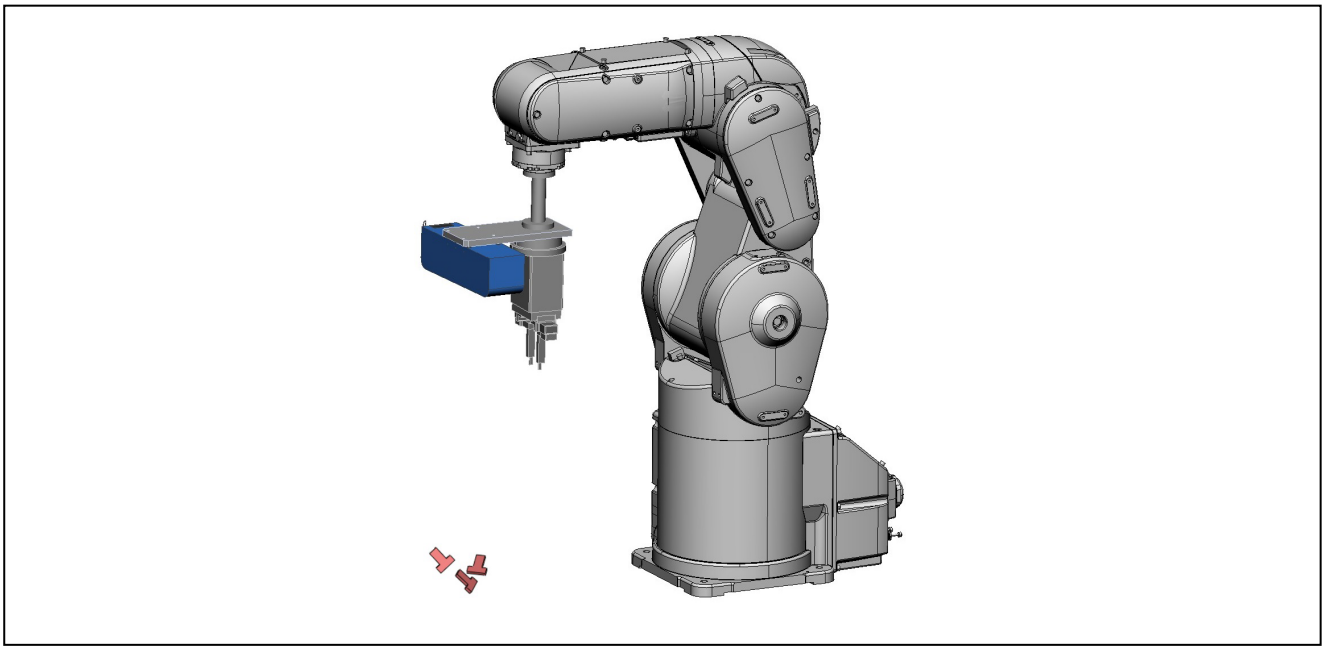
Gripping and delivery of bulk loaded workpieces

- The hand moves to the measurement position, and JOB 1 is executed for measurement and recognition.
- The execution workpiece position is selected from the grip position candidates obtained using the workpiece recognition position and correction vector.
- The hand moves to the execution grip position and grips the workpiece.
- The workpiece is taken out.
- The workpiece is delivered.

⚠ Caution

Since checking of occurrence of interference with surrounding objects for gripping of workpiece is not performed, do not use a parts supply box and load workpieces in bulk on a flat surface.

Before starting automatic operation, make sure that there are no obstacles in the surroundings. Be aware of the override speed.
If communication cannot be established properly among the camera, robot, and control unit, automatic operation may stop.



■ Sample program <Sample Program JMMH.prg>

```
'[Arrangement declaration]
Dim PMAT(10)                    'Correction vector: Enter correction vector calculated beforehand.
Dim PG_GRASP(10)                'Grip position candidate
Dim PG_CATCH(10)                'Teaching grip position
Dim MFLAG(10)                   'Within operating range flag
'[Variable initialization]
MDEG = 20                       'Angle threshold between teaching position and recognition grip position
'[Connection to MELFA-3D Vision]
If M_Open(1) <> 2 Then          'If vision sensor No. 1 is not capable of measurement
   V3Open "COM2:" As #1         'Connect to vision sensor connected to COM2: and set number to 1.
EndIf
Wait M_Open(1) = 2              'Connect to vision sensor No. 1 and wait until measurement is possible.
While 1
   '[Measurement, recognition]
   Mov PCap                     'Move to measurement position.
   Dly 1                        'Wait for robot tip vibrations to subside.
   V3Run #1,"JOB1", 1, 1, 1, 1, 1   'Execute "JOB1" Note 1.
   *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1   'Wait until result received from MELFA-3D Vision.
```

```
  If M_V3Rslt(1) <> 0 Then Error 9100              'Output error 9100 if unsuccessful.
  MNum = M_V3Num(1)                               'Store recognition count in MNum.
  If MNum = 0 Then Goto *FIN                      'Recognition count is 0 and therefore finished.
  PVSDATA = P_V3Pos(1, 1)                         'Acquire recognition result.
  '[Operating range check]
  MY02CHK = 0
  FOR MI = 1 TO 10
    PG_GRASP(MI) = PVSDATA * PMAT(MI)
    MFLAG(MI) = PosCq(PG_GRASP(MI))
    MY02CHK = MY02CHK + MFLAG(MI)
  NEXT MI
  IF MY02CHK = 0 THEN Error 9110        'Output error 9110 if all grip positions lie outside the operating range.
   '[Selection of grip position candidate for which difference in posture angle from teaching grip position is smallest]
  MIPMIN = -2
  FOR MI = 1 TO 10
    IF MFLAG(MI) = 1 THEN
       PCATCH  = PG_CATCH(MI)
       PGRASP  = PG_GRASP(MI)
      MIP = Dot(PCATCH, PGRASP)
                    'Convert specified position coordinates to unit vector and obtain inner product.
      IF MIP > MIPMIN THEN
        PG_PICK = PG_GRASP(MI)
        MIPMIN = MIP
      Endif
    Endif
  NEXT MI
       '[Check of difference in angle from teaching grip position]
  MTHRE = Cos(Rad(MDEG))
  IF MIPMIN < MTHRE THEN Error 9120
       'Output error 9120 if angular difference between teaching grip position and grip position exceeds threshold.
  '[Move to workpiece grip position ad grip workpiece]
  Mov PG_PICK, -30
  Mvs PG_PICK
  Dly 0.5
  Hclose 1
  Dly 0.5
  Mvs PG_PICK, -30
  '[Move to workpiece delivery position, and deliver workpiece]
  Mov PRel, -30
  Mvs PRel
  Dly 0.5
  HOpen 1
  Dly 0.5
  Mvs PRel, -30
WEnd
'[Termination processing]
*FIN
V3Close #1                          'Disconnect from vision sensor connected to COM2.
Hlt
End
```

9.6. Operation check

9.6.1. Monitoring

Jobs being executed are monitored. By clicking [Monitor] - [Measuring/Recognition Result] in the guidance menu at the MELFA-3D Vision setting screen, a Measurement/recognition results screen appears.

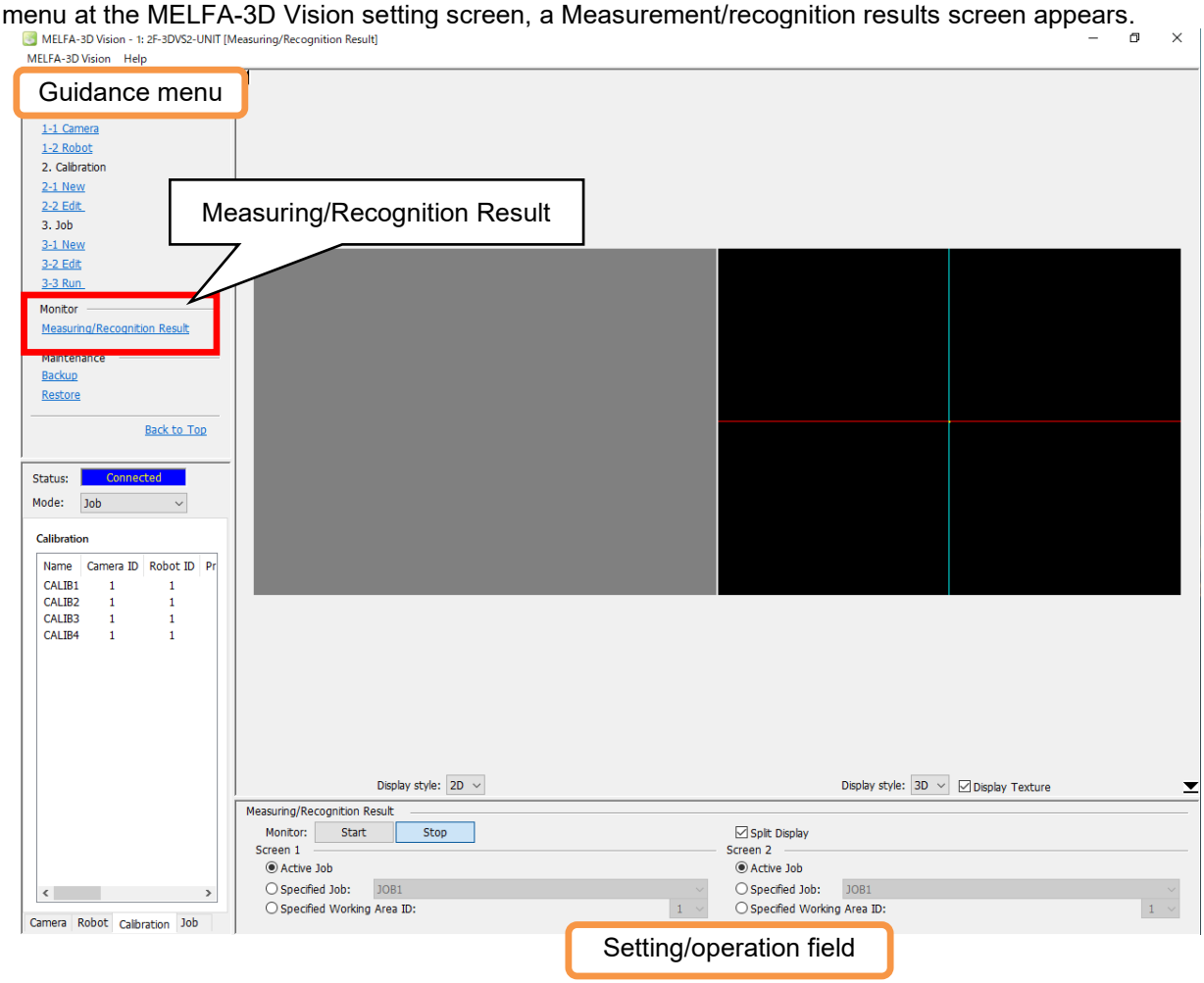


Fig. 9-8 Measurement and recognition results

The monitoring target can be selected from the following three.

Table 9-1 Monitoring types

Item	Description
Active Job	Monitors measurement and recognition results for the job currently being executed.
Specified Job	Monitors measurement and recognition results only for specified jobs.
Specified Working Area ID	Monitors measurement and recognition results stored in specified workspaces.

By selecting one of the above and clicking the [Start] button, monitoring is started.
Please note that two targets can be monitored simultaneously by selecting the "Two-division display" check box.

10. MELFA-3D Vision Application Exit

Right-click the [MELFA-3D Vision] icon in the task tray to display the context menu, and select the [Exit] menu to exit.

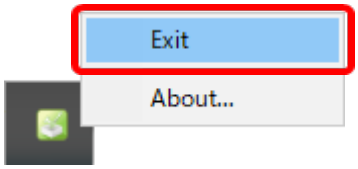


Fig.10-1 MELFA-3D Vision software exit method

11. Maintenance

11.1. Backup and restoration

Information stored inside the control unit can be backed up to the computer.
Furthermore, backup information saved to the computer can be restored to the control unit.

Table. 11-1: Backup and restoration

Item	Description
Backup (Control unit → computer)	Saves a backup of data in the control unit to the computer.
Restoration (Computer → control unit)	Transfers backup data saved in the computer to the control unit.

⚠ Caution

Do not disconnect the cable while backing up or restoring data. If disconnected during data transfer, it will not only be impossible to acquire data correctly, but control unit and computer operation may be adversely affected. Before disconnecting the cable, close the MELFA-3D Vision settings screen.

⚠ Caution

The data backed up in the conventional control unit cannot be restored to this software.

11.1.1. Backup

Save the data stored in the control unit.
By clicking [Maintenance] - [Backup] in the guidance menu at the MELFA-3D Vision setting screen, a Backup screen appears.

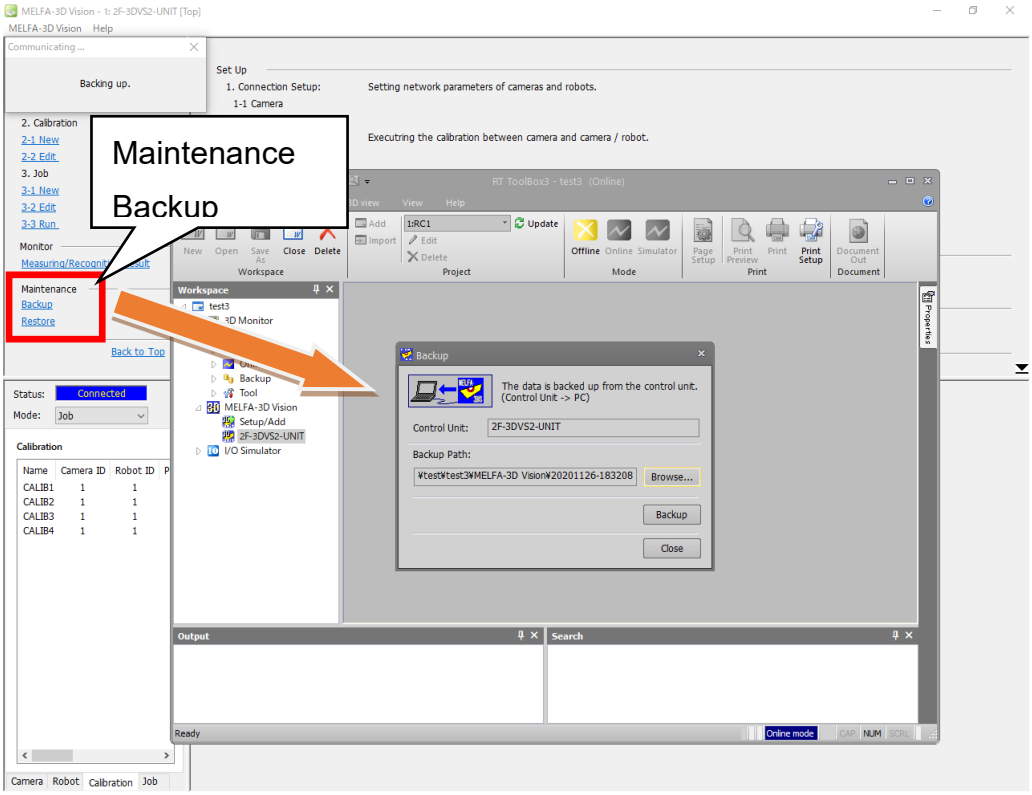


Fig.11-1 Backup

■ Specifying the backup location
Click the [Browse] button if necessary to change the backup location. The backup location is set from the factory as follows:
"Folder in which workspace created\Project name\MELFA-3D Vision\Control unit name_MAC address\Backup\Today's date and time"
■ Performing a backup
By clicking the [Backup] button, a confirmation screen appears. Following confirmation, click [Yes] to start the backup.

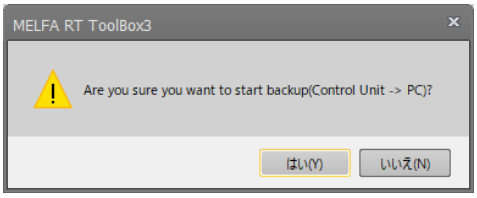


Fig.11-2 Backup confirmation screen

When the backup is completed, backup data appears under [MELFA-3D Vision] - [Control unit name] in the project tree.

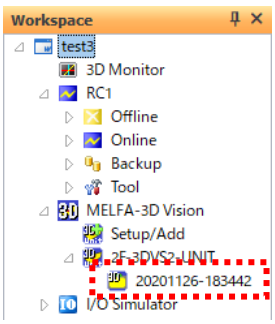


Fig.11-3 Backed up information display

11.1.2. Restoration

Information backed up in the computer can be transferred to the control unit.
By clicking [Maintenance] - [Restore] in the guidance menu at the MELFA-3D Vision setting screen, a Restoration screen appears.

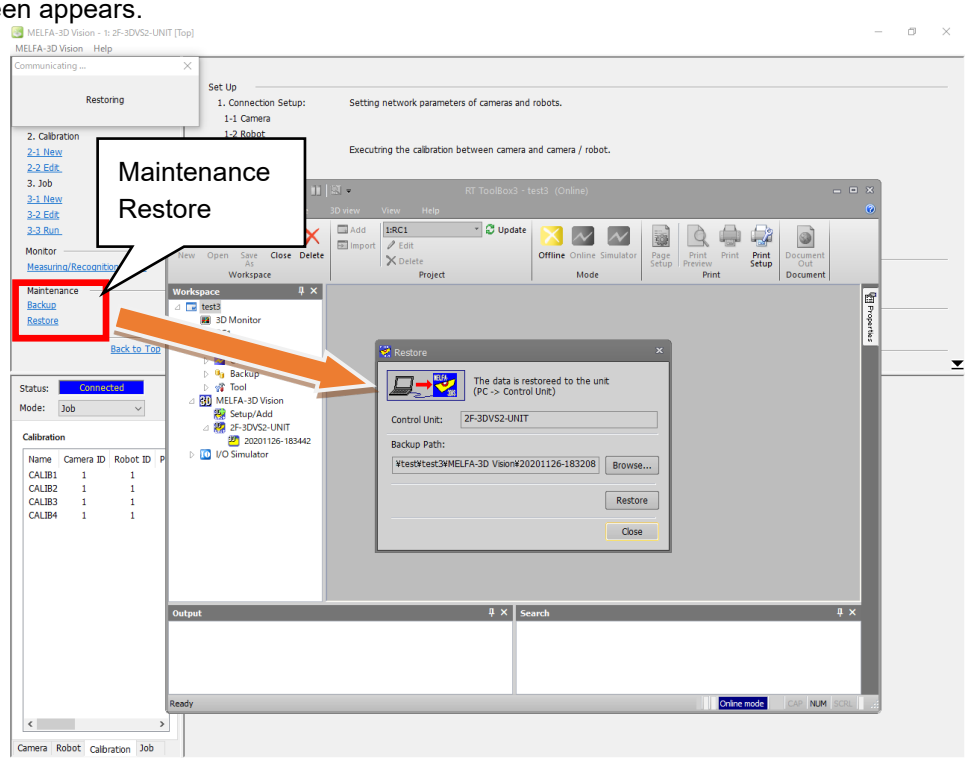


Fig.11-4 Restoration

■Specifying the restoration target
Click the [Browse] button and specify the location of the backup file to be restored.
■Performing restoration
By clicking the [Restore] button, a confirmation screen appears. Following confirmation, click [OK] to start the restoration. There is no need to reboot after the restoration is completed.

⚠ Caution

If editing or executing a job, end editing or execution before performing the restoration. Not doing so may cause unsuccessful restoration.

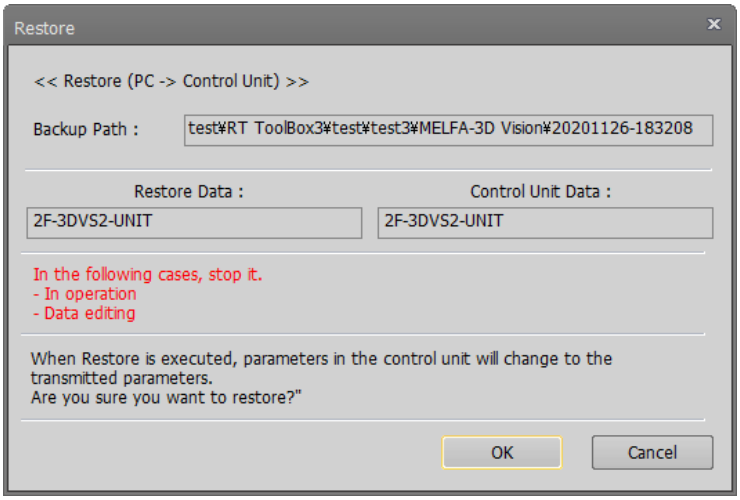


Fig.11-5 Restoration confirmation screen

11.2.Uninstallation procedure

11.2.1. MELFA-3D Vision software uninstallation

Run "Setup.exe" in the USB dongle.
Or, select "MELFA-3D Vision" from "Control Panel\All Control Panel Items\Program and Features", and click "Uninstall".
The language selected at the time of installation is used.

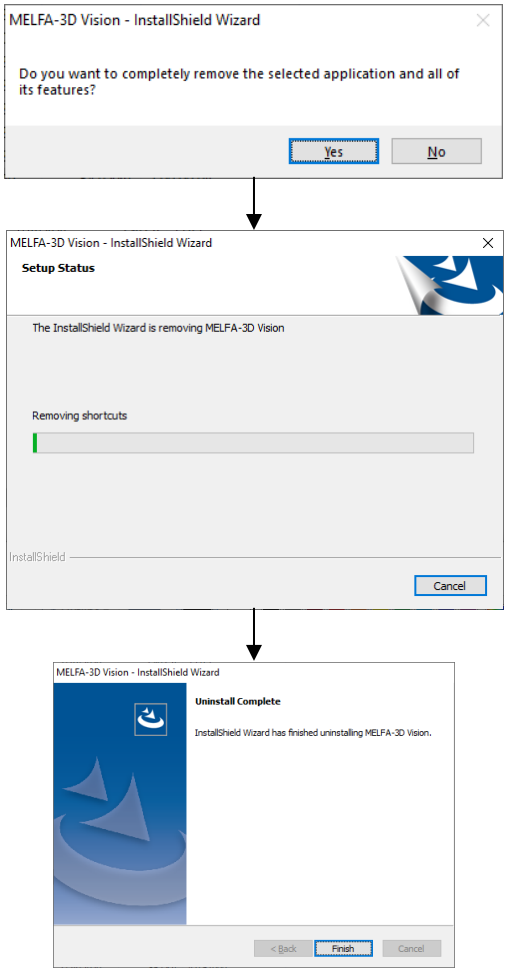
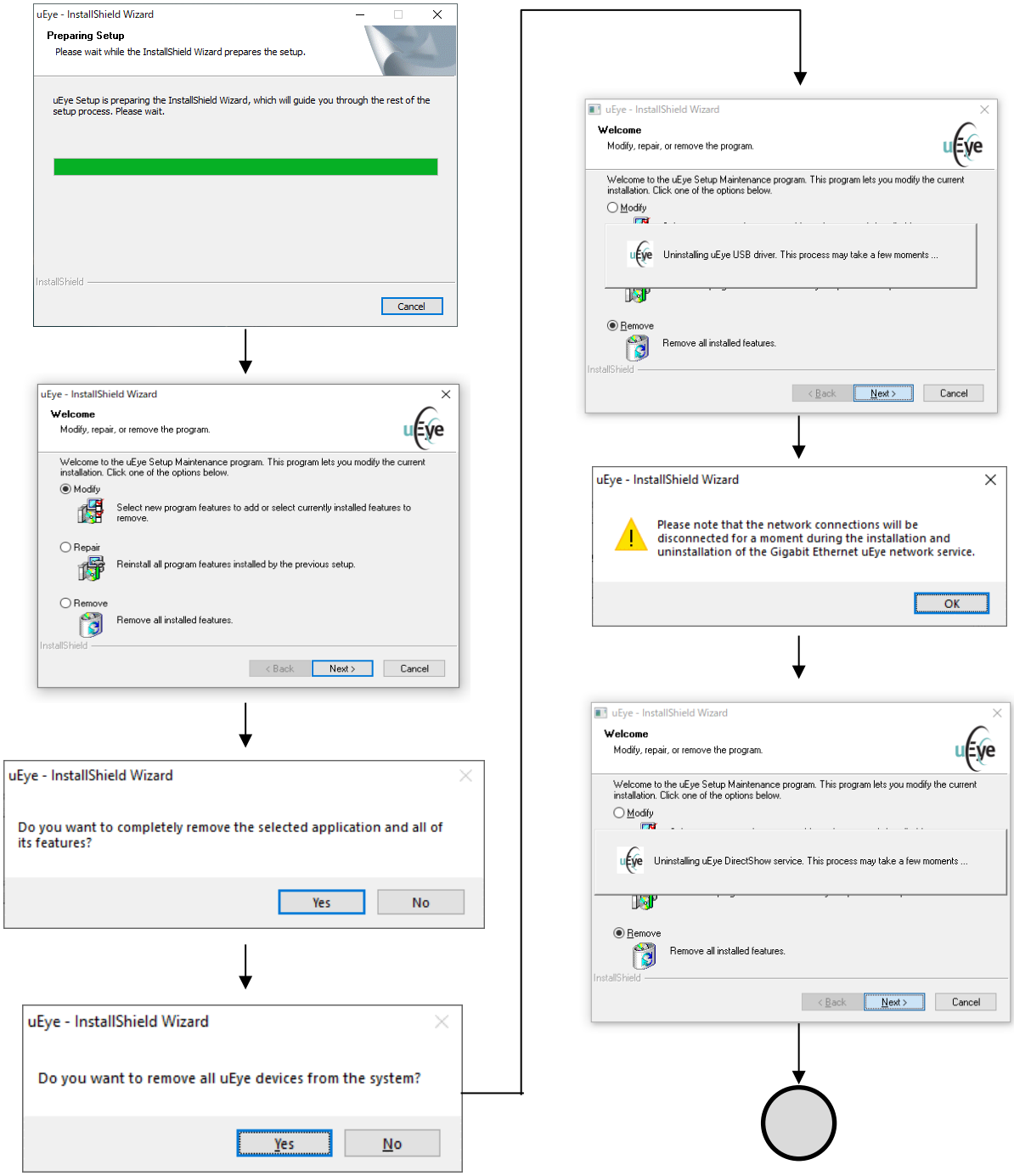


Fig.11-6 MELFA-3D Vision software uninstallation procedure

11.2.2. Uninstalling the camera driver and SDK

Perform the uninstallation manually before updating the camera driver and SDK.
In Control Panel, select [All Control Panel Items] → [Program and Features] → [IDS uEye] and [EnsensoSDK], and click [Uninstall].



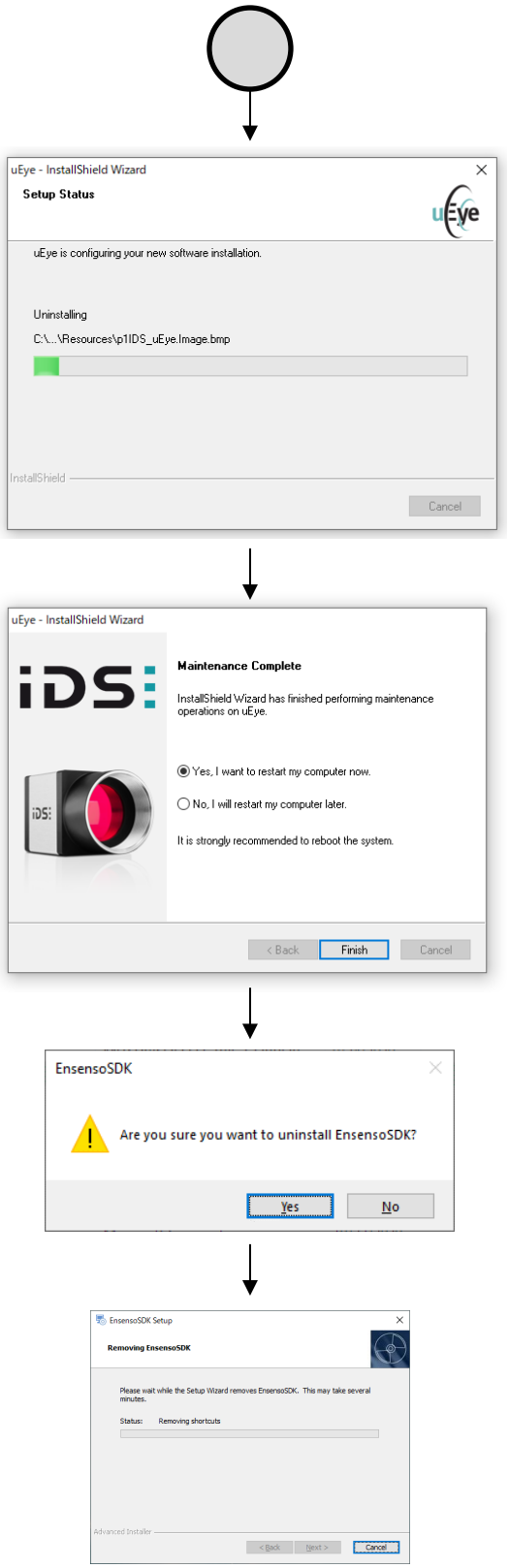


Fig.11-7 Camera driver uninstallation procedure

12. ROBOT PROGRAM LANGUAGE SPECIFICATIONS

12.1. MELFA-3D Vision Related Commands

Table 12-1: Command list

Command name	Function
V3Open	Connects to MELFA-3D Vision and enables measurement.
V3Close	Disconnects from MELFA-3D Vision.
V3Run	Executes the job.
V3Calib	Transmits calibration information.

V3Open

[Function]

Connects to the specified MELFA-3D Vision and enables measurement.

[Syntax]

V3Open "<COM No.>" AS # <Vision sensor No.>

[Term]

<COM No.>: [Character string]

Specifies the communication connection No. in the same way as the Open command.
"COM1:" cannot be specified.
Setting range: "COM2:" to "COM8:"

<Vision sensor No.>: [Integer type]

Specify a constant from 1 to 8 (Vision sensor No.). The MELFA-3D Vision unit connected to the COM specified with the <COM No.> is expressed with a number.
Furthermore, since this number is shared with the Open command <File No.>, caution is advised.
Setting range: 1 to 8

[Example]

```
1. If M_Open(1) <> 2 Then     'If vision sensor No. 1 is not capable of measurement
2. V3Open "COM2:" As #1       'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3. EndIf
4. Wait M_Open(1) = 2         'Connect to vision sensor No. 1 and wait until measurement is possible.
```

[Description]

(1) A connection is established to MELFA-3D Vision using the line specified with the <COM No.>.
(2) It is possible to connect to up to seven MELFA-3D Vision units simultaneously. The "Vision sensor No." is used to identify which MELFA-3D Vision unit to communicate with.
(3) If using together with the Open command, the Open command <COM No.>, <File No.>, and <COM No.> for this command are shared. Therefore, it is necessary to use numbers other than those specified with the Open command <COM No.> and <File No.>.

Normal example	Example resulting in error
1. Open "COM1:" As #1 2. V3Open "COM2:" As #2 3. V3Open "COM3:" As #3	1. Open "COM2:" As #1 2. V3Open "COM2:" As #2 ⇒ <COM No.> already used. 3. V3Open "COM3:" As #1 ⇒ <Vision sensor No.> already used.

(4) The communication status with MELFA-3D Vision when this command is executed can be checked with the status variable M_Open. Refer to the M_Open description for details.
(5) Communication stops immediately if the program is aborted while executing this command. It is necessary to reset the program and reboot in order to communicate with MELFA-3D Vision.
(6) If interrupt conditions are established while executing this command, interrupt processing is performed after processing of this command is completed.
(7) The connection is not closed with program End command called with the CallP command, however, the connection is closed with the main program End command. The connection is also closed when the program is reset.

[Related status variable]

Status variable	Description
M_Open	Returns the connection status.

[Related command]

Command	Description
V3Close	Disconnects from MELFA-3D Vision.
V3Run	Starts the program for MELFA-3D Vision.
V3Calib	Acquires calibration images for MELFA-3D Vision.

[Related parameter]

Parameter name	Description
OPNTOUT	Open command timeout

V3Close

[Function]
Disconnects from the specified MELFA-3D Vision unit.

[Syntax]

V3Close [[#]<Vision sensor No.> [,[[#]<Vision sensor No.>...]

[Term]
<Vision sensor No.> (can be omitted): [Integer type]
Specifies the MELFA-3D Vision unit number to be controlled (setting range: 1 to 8).
When omitted, all connections established by the V3Open command or Open command are closed.

[Example]

```
1.  If M_Open(1) <> 2 Then   'If vision sensor No. 1 is not capable of measurement
2.  V3Open "COM2:" As #1     'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3.  EndIf
4...
20. V3Close #1               'Disconnect from MELFA-3D Vision connected to COM2.
```

[Description]
(1) Disconnects from the MELFA-3D Vision unit to which a connection was established with the V3Open command.
(2) If the <Vision sensor No.> is omitted, all connections are closed.
(3) If a connection has been already closed, the process proceeds to the next step.
(4) It is possible to connect to up to seven MELFA-3D Vision units simultaneously. Therefore, the <Vision sensor No.> is used to identify the MELFA-3D Vision unit to be disconnected.
(5) If the program is aborted while executing this command, execution is continued until processing of this command is completed.
(6) If the End command is used, all connections established by the V3Open or Open command are closed. However, connections are not closed with End command inside programs called with the CallP command. Furthermore, connections are also closed when resetting the program. Therefore, if the End command is specified or the program is reset, there is no need to close connections using this command.
(7) If interrupt conditions are established while executing this command, interrupt processing is performed after processing of this command is completed.

[Related status variable]

Status variable	Description
M_Open	Returns the connection status.

[Related commands]

Command	Description
V3Open	Connects to MELFA-3D Vision.
V3Run	Starts the program for MELFA-3D Vision.
V3Calib	Acquires calibration images for MELFA-3D Vision.

V3Run

[Function]

Executes the specified job and saves the result to MELFA-3D Vision. The robot does not receive the result with this command. The result for which the command was executed is stored in M_V3Rslt.

[Syntax]

V3Run #<Vision sensor No.>, <Job name>, <Workspace ID>, <Measurement flag>, <Recognition flag> [, <Recognition target No.>[, <Storage destination No.>]]

[Term]

<Vision sensor No.>: [Integer type]
Specifies the MELFA-3D Vision unit number to be controlled (setting range: 1 to 8).

<Job name>: [Character string]
Specifies the name of the job (vision program) to be started.
Only characters '0' to '9', 'A' to 'Z', 'a' to 'z', '-', and '_' can be used, and it must be within 15 characters.

<Workspace ID>: [Integer type]
Specifies the MELFA-3D Vision workspace for which vision processing is performed.
Setting range: 1 to 8

<Measurement flag>: [Integer type]
Specifies whether to create a range image.
Setting range: 0 = Don't create, or 1 = Create

<Recognition flag>: [Integer type]
Specifies whether to perform image recognition.
Setting range: 0 = Don't perform recognition or 1 = Perform recognition

<Recognition target No.> (can be omitted): [Integer type]
Specifies the recognition target No. (model and recognition parameter corresponding to that model) specified in the workpiece list at MELFA-3D Vision. (For model matching only)
Setting range: 1 to 8
Judged as "1" when omitted.

<Storage destination No.> (can be omitted): [Integer type]
Specifies the number for the area in which the recognition result is stored.
Setting range: 1 to 10 * Judged as "1" when omitted.

If, for example, "2" is specified, the recognition result is stored below.
M_V3Rslt(2) / M_V3Num(2) / P_V3Pos(2,1) to (2,10) / M_V3Rmn1(2) / M_V3Rmn2(2)

[Example]

```
1.  If M_Open(1) <> 2 Then     'If vision sensor No. 1 is not capable of measurement
2.  V3Open "COM2:" As #1       'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3.  EndIf
4.  Wait M_Open(1) = 2         'Connect to vision sensor No. 1 and wait until measurement is possible.
5.  Mov PCap                   'Move to measurement position.
6.  V3Run #1, "TEST", 5, 1, 1 'Execute job name "TEST".
7.  *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1'Wait until result received from MELFA-3D Vision.
8.  If M_V3Rslt(1) <> 0 Then Error 9100'Output error 9100 if unsuccessful.
9...
15. V3Close #1                 'Disconnect from MELFA-3D Vision connected to COM2.
```

[Description]

(1) Executes the job for the specified MELFA-3D Vision unit.
(2) This command prompts a move to the next step after sending a measurement processing command to MELFA-3D Vision.
(3) Communication stops immediately if the program is aborted while executing this command.
(4) Since MELFA-3D Vision writes the recognition result to a status variable, the applicable status variable should be used after checking M_V3Rslt().
(5) If interrupt conditions are established while executing this command, interrupt processing is performed after processing of this command is completed.
(6) If the timeout time specified in parameter "V3TMOUT" is exceeded, an 8632 error occurs.
By restarting the robot program following the occurrence of this error, a request is sent to MELFA-3D Vision again.

[Related status variables]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.
M_V3Num	Returns the recognition count.
P_V3Pos	Returns the position of the recognized workpiece.

[Related commands]

Command	Description
V3Open	Connects to MELFA-3D Vision.
V3Close	Disconnects from MELFA-3D Vision.
V3Calib	Acquires calibration images for MELFA-3D Vision.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

V3Calib

[Function]
Transmits calibration image acquisition requests.

[Syntax]

V3Calib #<Vision sensor No.>, <Posture ID> [, <Storage destination No.>]

* For V3Calib, posture IDs are not used in MELFLA-3D Vision 3.0 and thus they are invalid.

[Term]
<Vision sensor No.>: [Integer type]
Specifies the MELFA-3D Vision unit number to be controlled (setting range: 1 to 8).
<Posture ID>: [Integer type]
Images at eight locations are required to perform calibration. Move to the position for each location and specify the respective posture ID.
Setting range: 1 to 8
Posture IDs are not used in MELFA-3D Vision 3.0.

<Storage destination No.> (can be omitted): [Integer type]
Specifies the number for the area in which the recognition result is stored.
Setting range: 1 to 10 * Judged as "1" when omitted.

If, for example, "5" is specified, the recognition result is stored below.
M_V3Err(5) / M_V3Rslt(5)

[Example]
```
1.  If M_Open(1) <> 2 Then     'If vision sensor No. 1 is not capable of measurement
2.  V3Open "COM2:" As #1       'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3.  EndIf
4.  Wait M_Open(1) = 2         'Connect to vision sensor No. 1 and wait until measurement is possible.
5...
10 While MOK = 0
11 V3Calib #2, 1, 1
12 *LP1:If M_V3Rslt(1) = -1 GoTo *LP1
13 If M_V3Rslt(1) = 0 Then MOK = 1
14 If M_V3Rslt(1) > 0 Then *ER
15 PG_POS = P_V3Pos(1, 1) * PTL
16 If PosCq(PG_POS) = 1 Then Mvs PG_POS
17 Dly 0.5
18 WEnd
19 ・・・
26. *Loop4:If M_V3Rslt(5) < 0 Then Goto *Loop4      'Wait for response from MELFA-3D Vision.
27. If M_V3Rslt(5) <> 0 Then Error 9101             'Output error 9101 if unsuccessful.
28...
35. V3Close #1                 'Disconnect from MELFA-3D Vision connected to COM2.
```

[Description]
(1) A calibration image acquisition request is sent to the specified MELFA-3D Vision unit.
(2) Since MELFA-3D Vision returns an immediate reply statement after receiving the request, it is necessary to check M_V3Rslt at the next step. If there is no response even after the timeout time specified in parameter "V3TMOUT" is exceeded, an error occurs.
By restarting the robot program following the occurrence of this error, a request is sent to MELFA-3D Vision again.
(3) If interrupt conditions are established while executing this command, interrupt processing is performed after processing of this command is completed.

[Related status variable]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.

[Related commands]

Command	Description
V3Open	Connects to MELFA-3D Vision.
V3Close	Disconnects from MELFA-3D Vision.
V3Run	Starts the program for MELFA-3D Vision.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

12.2.MELFA-3D Vision Related Status Variables

Table 12-2: Robot (system) status variable list

Variable name	Array qty	Function	Attributes Note 1	Data type
M_Open(m) m = File No.	File No. 1 to 8	Returns the MELFA-3D Vision connection status.	R	Integer type
M_V3Rslt(n) n = Storage destination No.	Storage destination No. 1 to 10	The command result is stored in MELFA-3D Vision. (1) Initialized to "-1" when command V3Open/V3Close is executed. (2) Initialized to "-1" when command V3Run/ V3Calib is executed, and the above value is stored depending on the response from MELFA-3D Vision. (3) When there is an error on the camera head, the value “6: Fail to measure” is stored. (Please refer Section 14.5 Q&A).	R/W Note 2	Integer type
M_V3Num(n) n = Storage destination No.	Storage destination No. 1 to 10	The recognized hand insertion position candidate quantity (model-less recognition) or the workpiece quantity (model matching recognition) is stored. 0 to 50 Note 3	R/W Note 2	Integer type
P_V3Pos(n, m) n = Storage destination No. m=Data number	Storage destination No. 1 to 10 Data number 1 to 50 Note 3	The recognized hand insertion position (model-less recognition) or the workpiece position (model matching recognition) is stored. (Max. 50) Note 3 The applicable coordinates are "XYZABC". Zero is entered for all additional axis information and structure flags. Please note that with model-less recognition, the positions in the base coordinate system are stored for X, Y, and Z, and the rotation angle around the Z-axis in the camera coordinate system is stored for C.	R/W Note 2	Position type
M_V3Rmn (n) Note 4 n = Storage destination No.	Storage destination No. 1 to 10	Refers to the workpiece residual amount calculated based on the height information with model-less recognition of MELFA-3D Vision. For the storage destination No., specify the storage destination No. 1 to 10 specified with the V3Run command. -1: Initial value	R/W Note 2	Integer type
M_V3Rmn2 (n) Note 4 n = Storage destination No.	Storage destination No. 1 to 10	Refers to the workpiece residual amount calculated based on the recognition range information with model-less recognition of MELFA-3D Vision. For the storage destination No., specify the storage destination No. 1 to 10 specified with the V3Run command. -1: Initial value	R/W Note 2	Integer type

Note 1: R...Read only, R/W...Read and write both possible
Note 2: Writing is possible because data is written from the control unit.
Note 3: For CR750/CR751 series controllers, the upper limits of the recognition number and the data / index number change depending on the software version.
- Ver.R6e/S6e or later: Up to 50
- Ver.R6e/S6e or earlier: Up to 10

Note 4: Available with the CR800 series controller Ver.A3 or later.

M_Open

[Function]
Represents the (MELFA-3D Vision) connection status for the specified file.

[Syntax]

<Numeric variable> = M_Open[(<File No.>)]

[Term]
<Numeric variable>
Specifies a numeric variable to be substituted by the result.

<File/Vision sensor No.> (can be omitted): [Integer type]
Specifies a constant of the file (vision sensor) number (1 to 8) specified with the Open/V3Open command.
Judged as "1" when omitted.

Argument types that can be used
<Numeric variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	×	×	×
Variable	○	○	○	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration)

<File No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	Δ	Δ	×	×	×
Variable	○	Δ	Δ	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (rounded off to integer values)

[Return value description]
-1: Not connected
0: Connecting
1: Connection completed
2: Measurement possible (for MELFA-3D Vision only)

[Example]

```
1.  If M_Open(1) <> 2 Then      'If vision sensor No. 1 is not capable of measurement
2.  V3Open "COM2:" As #1        'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3.  EndIf
4.  Wait M_Open(1) = 2          'Wait until vision sensor No. 1 is capable of measurement.
5...
10. V3Close #1                  'Disconnect from MELFA-3D Vision connected to COM2:.
```

[Description]

(1) Represents the status of the connection with MELFA-3D Vision established with the V3Open command.
(2) The initial value is "-1". When the V3Open command is executed, the value becomes "0" during the connection processing. Then, the value becomes "1" when connection processing is completed, and finally it becomes "2" when measurement is possible.
(3) This variable is only available for the slots in which the Open or V3Open command was executed (cannot be referenced from other slots).

[Related commands]

Command	Description
V3Open	Connects to MELFA-3D Vision.
V3Close	Disconnects from MELFA-3D Vision.

[Related status variable]

Command	Description
M_NvOpen	Returns the status of the connection with the network vision sensor.

[Related parameter]

Parameter name	Description
OPNTOUT	Open command timeout

M_V3Rslt

[Function]
The processing result corresponding to the request sent to MELFA-3D Vision is stored.

[Syntax]

<Numeric variable> = M_V3Rslt[(<Storage destination No.>)]

[Term]
<Numeric variable>
Specifies a numeric variable to be substituted by the result.
<Storage destination No.> (can be omitted): [Integer type]
Specifies the storage destination (No. 1 to 10) that is specified with the V3Run/V3Calib command.

Argument types that can be used
<Numeric variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	×	×	×
Variable	○	○	○	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration)

<Storage destination No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	Δ	Δ	×	×	×
Variable	○	Δ	Δ	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (rounded off to integer values)

[Return value description]
-2: Executing job
-1: Default (automatic initialization when transmission successful)
0: Job execution successful
1: Unsuccessful
* For the error details, refer to "14.4 MELFA-3D Vision Error Code Details".

[Example]

```
1. If M_Open(1) <> 2 Then      'If vision sensor No. 1 is not capable of measurement
2. V3Open "COM2:" As #1        'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3. EndIf
4. Wait M_Open(1) = 2          'Connect to vision sensor No. 1 and wait until measurement is possible.
5. Mov PCap                    'Move to measurement position.
6. V3Run #1, "TEST", 5, 1, 1 'Execute job name "TEST".
7. *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1        'Wait until result received from MELFA-3D Vision.
8. If M_V3Rslt(1) <> 0 Then Error 9100               'Output error 9100 if unsuccessful.
9...
20. V3Close #1                 'Disconnect from MELFA-3D Vision connected to COM2.
```

[Description]

(1) Stores the result from MELFA-3D Vision when the V3Run/V3Calib command is executed.
(2) "-1" is stored when starting up. The value is initialized to "-1" each time a command is executed.
(3) When the robot controller software version is earlier than Ver.E4, the MELFA Smart Plus card needs to be set to execute the job created using the MELFA-3D Vision extended function. When the MELFA Smart Plus card is not set, the error No. 3780 (Cannot use the MELFA Smart Plus.) is stored.

[Related commands]

Command	Description
V3Run	Starts the program for MELFA-3D Vision.
V3Calib	Acquires calibration images for MELFA-3D Vision.

[Related status variables]

Status variable	Description
M_V3Num	Returns the recognition count.
P_V3Pos	Returns the position of the recognized workpiece.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

M_V3Num

[Function]

The recognized hand insertion position candidate quantity (model-less recognition) or the workpiece quantity (model matching recognition) is stored.

Note: For CR750/CR751 series controllers, the upper limit of the recognition number changes depending on the software version.

- Ver.R6e/S6e or later: Up to 50
- Ver.R6e/S6e or earlier: Up to 10

[Syntax]

<Numeric variable> = M_V3Num[(<Storage destination No.>)]

[Term]

<Numeric variable>

Specifies a numeric variable to be substituted by the result.

<Storage destination No.> (can be omitted): [Integer type]

Specifies the storage destination (No. 1 to 10) specified with the V3Run command.

Argument types that can be used

<Numeric variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	×	×	×
Variable	○	○	○	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration)

<Storage destination No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	Δ	Δ	×	×	×
Variable	○	Δ	Δ	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (rounded off to integer values)

[Example]

```
1. If M_Open(1) <> 2 Then      'If vision sensor No. 1 is not capable of measurement
2. V3Open "COM2:" As #1        'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3. EndIf
4. Wait M_Open(1) = 2          'Connect to vision sensor No. 1 and wait until measurement is possible.
5. Mov PCap                    'Move to measurement position.
6. V3Run #1, "TEST", 5, 1, 1 'Execute job name "TEST".
7. *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1      'Wait until result received from MELFA-3D Vision.
8. If M_V3Rslt(1) <> 0 Then Error 9100             'Output error 9100 if unsuccessful.
9. MNum = M_V3Num(1)                               'Store recognition result in MNum.
10. If MNum = 0 Then Goto *FIN                     'Recognition count is 0 and therefore finished.
11...
15. *FIN
16...
20. V3Close #1                 'Disconnect from MELFA-3D Vision connected to COM2.
```

[Description]

(1) The hand insertion position candidate quantity (model-less recognition) or the workpiece quantity (model matching recognition) recognized when executing the V3Run command is stored.
(2) "0" is stored when starting up. The value is initialized to "0" each time a command is executed.

[Related command]

Command	Description
V3Run	Starts the program for MELFA-3D Vision.

[Related status variables]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.
P_V3Pos	Returns the position of the recognized workpiece.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

P_V3Pos

[Function]

The hand insertion position (model-less recognition) or the workpiece position (model matching recognition) recognized by MELFA-3D Vision is stored.

[Syntax]

<Position variable> = P_V3Pos(<Storage destination No.>, <Data No.>)

[Term]

<Position variable>

Specifies a position variable to be substituted by the result.

<Storage destination No.>: [Integer type]

Specifies the storage destination (No. 1 to 10) specified with the V3Run command.

<Data No.>: [Integer type]

Specifies the number (1 to 50) in which recognized data is stored.

Note: For CR750/CR751 series controllers, the upper limit of the data number changes depending on the software version.

- Ver.R6e/S6e or later: Up to 50
- Ver.R6e/S6e or earlier: Up to 10

Argument types that can be used

<Position variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	Δ	×	×
Variable	×	×	×	○	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (× for substitution destination from status variable)

<Storage destination No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	Δ	Δ	×	×	×
Variable	○	Δ	Δ	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (rounded off to integer values)

<Data No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	Δ	Δ	×	×	×
Variable	○	Δ	Δ	×	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), Δ (rounded off to integer values)

[Return value description]

Model-less recognition: Base coordinate system positions for X, Y, and Z, and rotation angle around Z-axis in camera coordinate system for C (-90º ≤ C < 90º)

[Example]

```
1.  If M_Open(1) <> 2 Then      'If vision sensor No. 1 is not capable of measurement
2.  V3Open "COM2:" As #1        'Connect to MELFA-3D Vision connected to COM2: and set number to 1.
3.  EndIf
4.  Wait M_Open(1) = 2          'Connect to vision sensor No. 1 and wait until measurement is possible.
5.  Mov PCap                    'Move to measurement position.
6.  V3Run #1, "TEST", 5, 1, 1 'Execute job name "TEST".
7.  *Loop1:If M_V3Rslt(1) < 0 Then Goto *Loop1      'Wait until result received from MELFA-3D Vision.
8.  If M_V3Rslt(1) <> 0 Then Error 9100             'Output error 9100 if unsuccessful.
9.  MNum = M_V3Num(1)                               'Store recognition result in MNum.
10. If MNum = 0 Then Goto *FIN                      'Recognition count is 0 and therefore finished.
11. PRcg = P_V3Pos(1,1)     'Store recognized position in PGet.
12. PRot = P_Zero
13. PRot.C = PRcg.C         'Extract C component from recognition result.
14. PHnd = P_Zero
15. If PRot.C>0 Then PHnd.C = -90DEG Else PHnd.C = +90DEG
16. PAp.X = PRcg.X
17. PAp.Y = PRcg.Y
18. PAp.Z = 150             'Substitute height over parts supply box.
19. PAp.A = PCap.A          'Align with measurement position posture.
20. PAp.B = PCap.B
21. PAp.C = PCap.C
22. PAp = Pap * PRot        'Calculate hand posture alignment position.
23. PGet = PAp
24. PGet.Z = PRcg.Z - 20    'Subtract amount of claw thrust amount (roughly three fourths of workpiece
    height).
25. Mvs PAp                 'Hand posture alignment
26. Mvs PGet                'Entry and gripping
27. Dly 0.5
28. HClose 1
29. Dly 0.5
30. Mvs PAp
31...
40. *FIN
41...
50. V3Close #1              'Disconnect from MELFA-3D Vision connected to COM2:.
```

[Description]

(1) The hand insertion position (model-less recognition) or the workpiece position (model matching recognition) when executing the V3Run command is stored. The recognition score is stored in order from the higher score from data No. = 1.

(2) P_Zero is stored when starting up. The value is initialized to P_Zero each time a command is executed.

(3) If M_V3Rslt is not 0, or if M_V3Num is 0, and illegal value has been stored, do not use the value.

[Related command]

Command	Description
V3Run	Starts the program for MELFA-3D Vision.

[Related status variables]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.
M_V3Num	Returns the recognition count.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

M_V3Rmn1

[Function]

Refers to the workpiece residual amount calculated based on the height information with model-less recognition of MELFA-3D Vision.

[Syntax]

<Numeric variable> = M_V3Rmn1[(<Storage destination No.>)]

[Term]

<Numeric variable>

Specifies a position variable to be substituted by the result.

<Storage destination No.> (can be omitted) [Integer type]

Specifies the storage destination (No. 1 to 10) specified with the V3Run command.

Argument types that can be used

<Position variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	×	×	×
Variable	○	○	○	○	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), △ (× for substitution destination from status variable)

<Storage destination No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	○	△	△	×	×
Variable	○	○	△	△	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), △ (rounded off to integer values)

[Example]

```
1 MRmn1 = M_V3Rmn1(1)   'Obtain the workpiece residual amount.
```

[Description]

(1) When the workpiece residual amount is not calculated, "-1" is returned. Check the parameter of the recognition job for MELFA-3D Vision and set it to calculate the workpiece residual amount. (The initial value is "-1".)

[Related command]

Command	Description
V3Run	Starts the program for MELFA-3D Vision.

[Related status variables]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.
P_V3Pos	Returns the position of the recognized workpiece.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

M_V3Rmn2

[Function]
Refers to the workpiece residual amount calculated based on the recognition range information with model-less recognition of MELFA-3D Vision.

[Syntax]

<Numeric variable> = M_V3Rmn2[(<Storage destination No.>)]

[Term]
<Numeric variable>
Specifies a position variable to be substituted by the result.
<Storage destination No.> (can be omitted) [Integer type]
Specifies the storage destination (No. 1 to 10) specified with the V3Run command.

Argument types that can be used
<Position variable>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	×	×	×	×	×	×
Variable	○	○	○	○	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), △ (× for substitution destination from status variable)

<Storage destination No.>

	Numeric type			Position type	Joint type	Character string type
	Integer	Real number	Double-precision real number			
Constant	○	○	△	△	×	×
Variable	○	○	△	△	×	×
Logical/arithmetic expression	×	×	×	×	×	×
Function	×	×	×	×	×	×

○: Can be used, ×: Cannot be used (a syntax error occurs on registration), △ (rounded off to integer values)

[Example]

```
1 MRmn2 = M_V3Rmn2(1)     'Obtain the workpiece residual amount.
```

[Description]
(1) When the workpiece residual amount is not calculated, "-1" is returned. Check the parameter of the recognition job for MELFA-3D Vision and set it to calculate the workpiece residual amount. (The initial value is "-1".)

[Related command]

Command	Description
V3Run	Starts the program for MELFA-3D Vision.

[Related status variables]

Status variable	Description
M_V3Rslt	Returns the image processing execution result.
P_V3Pos	Returns the position of the recognized workpiece.

[Related parameter]

Parameter name	Description
V3TMOUT	Communication timeout time

12.3.MELFA Smart Plus Card Related Status Variables

Table 12-3: Robot (system) status variable list

Variable name	Array qty	Function	Attributes Note 1	Data type
M_SmartPlus(ID)	ID 1	Refers to the availability of the MELFA Smart Plus function specified with <ID>.	R	Integer type
C_SmartPlus(ID)	ID 1	Returns the name of the MELFA Smart Plus function specified with <ID>.	R	Character type

Note 1: R...Read only.

M_SmartPlus

[Function]
Refers to the availability of each MELFA Smart Plus function.

[Syntax]

< Numeric variable > = M_SmartPlus(<ID>)

[Term]

< Numeric variable >	Specifies a numeric variable to be substituted. 0: Not available 1: Available
<ID>	Specifies the function ID. 1: Calibration support function 2: Robot mechanism temperature correction function 3: Additional axis cooperative control 4: Preventive maintenance 101: MELFA-3D Vision extended function

[Example]

```
1 M1 = M_SmartPlus (101)     'Refer to the availability of the MELFA-3D Vision extended function.
```

[Description]

(1) Refers to the availability of the MELFA Smart Plus function specified with <ID>.
(2) This variable is read-only.

C_SmartPlus

[Function]
Returns the name of the MELFA Smart Plus function.

[Syntax]

<Character string variable> = C_SmartPlus (<ID>)

[Term]

<Character string variable>	Specifies a character string variable to be substituted. Calibration assistance / Robot temperature compensation / Coordinated control for additional axes / Preventive Maintenance / Extended function of MELFA-3D Vision
<ID>	Specifies the function ID. 1: Calibration support function 2: Robot mechanism temperature correction function 3: Additional axis cooperative control 4: Preventive maintenance 101: MELFA-3D Vision extended function

[Example]

```
1 CMSP$ = C_SmartPlus(101)    'Obtain the name of the MELFA-3D Vision extended function.
```

[Description]

(1) Returns the name of the MELFA Smart Plus function specified with <ID>.
(2) This variable is read-only.

13. PARAMETER SPECIFICATIONS

13.1. MELFA-3D Vision Related Robot Parameter List

The following table shows a list of MELFA-3D Vision related robot parameters.

Table 13-1: MELFA-3D Vision related robot parameter list

Parameter	Parameter name	Array qty No. of characters	Description	Default setting
Controller IP address	NETIP	Character string 1	Specifies the robot controller IP address.	CR750-D/CR751-D, CR800-D/R/Q) 192.168.0.20 (CR750-Q/CR751-Q) 192.168.100.1
Server designation	NETMODE	Integer 9	Specifies whether to set the robot controller as a server or a client. 1: Server/0: Client * When using MELFA-3D Vision, specify "0: Client".	1, 1, 1, 1, 1, 1, 1, 1, 1
Protocol	CPRCE** ** = OPT No. (11 to 19)	Integer 1	Specifies the protocol. 0: Nonprocedural/1: Procedural/2: Data link * MELFA-3D Vision and robots are connected by "2: Data link".	0
Open command timeout	OPNTOUT	Real number 1	Specifies the Open command timeout time. Unit: sec * Open command processing is included in the V3Open command.	3.00
3D Vision communication timeout time	V3TMOUT	Integer 1	Specifies the timeout time when no reply is received after transmitting a command from the robot to MELFA-3D Vision. Unit: sec	3

14. TROUBLESHOOTING

14.1. MELFA-3D Vision Related Error List

The following error numbers consist of four digits plus 5 digits. The first four digits appear on the operation panel and the teaching pendant. The last five digits can be checked in the RT ToolBox3 error details display.

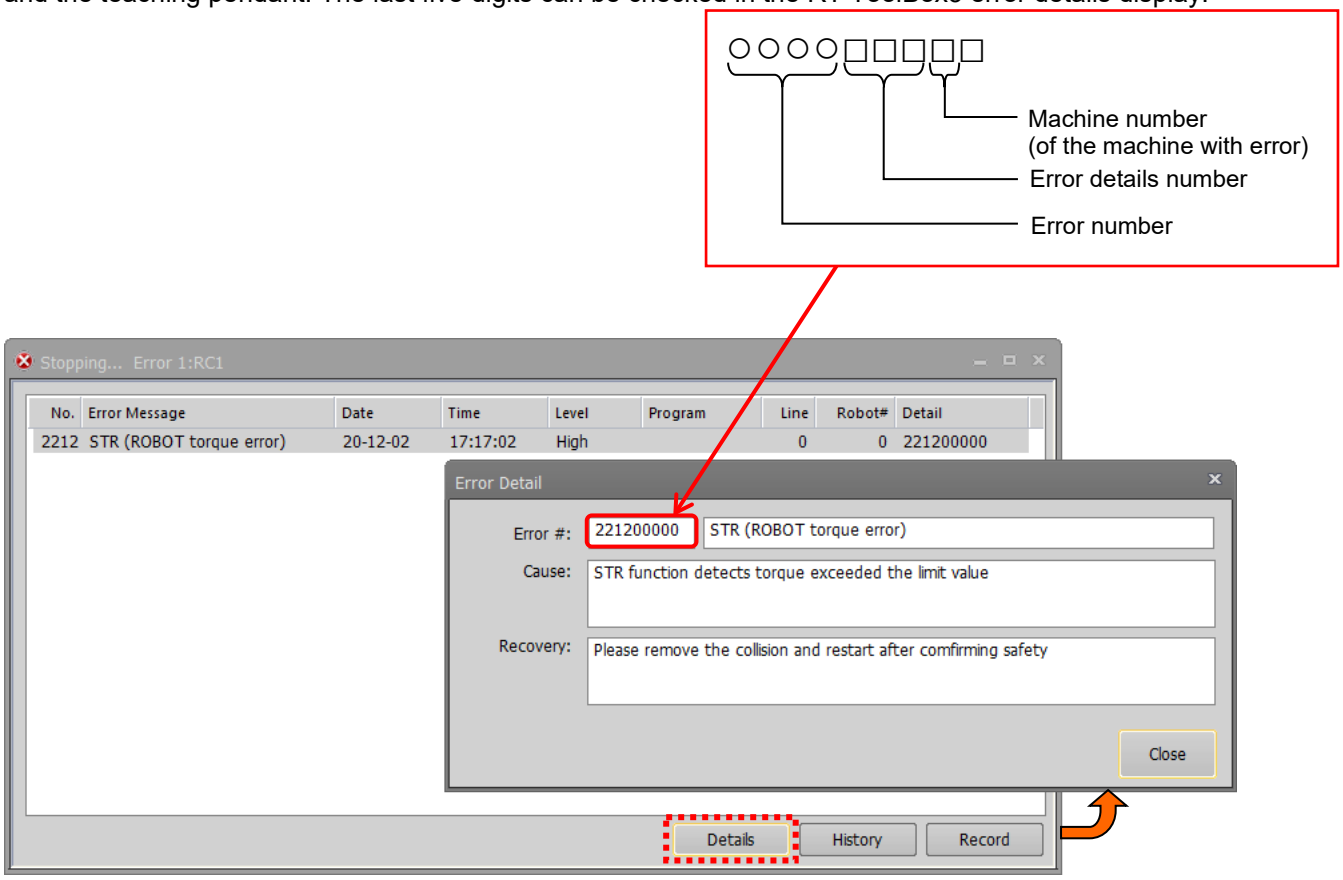


Fig. 14-1 Error details

Table 14-1: Error list

Error number	Error details
L_3110_00000	Arg. value range over
L_3120_00000	No. of arg. is over
L_3130_00000	COM file is already opened
L_3142_00000	Cannot open COM line
L_3143_00000	V3OPEN command not executed
L_3287_00000	Cannot execute (ERROR ALWAYS)
L_3810_00000	Different argument type
L_4220_00000	Syntax error
L_8610_00000	The communication is abnormal
L_8621_00000	Vision program name is abnormal
L_8632_00000	The vision is a time-out
L_8690_99000	Vision communication status error

14.2.MELFA-3D Vision Related Error Details

Table 14-2 Error details

Error No.		Error cause and countermeasure	
First 4 digits	Latter 5 digits		
L3110	00000	Error message	Arg. value range over
		Cause	The argument value lies outside the range.
		Countermeasure	Check the argument range and set a correct value.
L3120	00000	Error message	No. of argument is over
		Cause	The number of arguments is incorrect.
		Countermeasure	Check the quantity of arguments and set a correct value.
L3130	00000	Error message	COM file is already opened
		Cause	Opening of a file already opened was attempted.
		Countermeasure	Check the file No. and re-execute.
L3142	00000	Error message	Cannot open COM line
		Cause	The communication line cannot be opened.
		Countermeasure	Check the communication No. and re-execute.
L3143	00000	Error message	V3OPEN command not executed
		Cause	The required command has not been executed.
		Countermeasure	Check the specified file No.
L3287	00000	Error message	Cannot execute (ERROR ALWAYS)
		Cause	The command cannot be used when the start conditions are ERROR or ALWAYS.
		Countermeasure	Correct the program.
L3810	00000	Error message	Different argument type
		Cause	The argument type is different.
		Countermeasure	Specify a correct argument.
L4220	00000	Error message	Syntax error
		Cause	There is an error in the syntax of the input command statement.
		Countermeasure	Check the content and re-input a correct syntax.
L8610	00000	Error message	The communication is abnormal
		Cause	Communication with the vision sensor was disconnected.
		Countermeasure	Check the communication cable.
L8621	00000	Error message	Vision program name is abnormal
		Cause	The program name has exceeded 15 characters.
		Countermeasure	Specify the program name within 15 characters.
L8690	99000	Error message	Vision communication status error
		Cause	An error has occurred during communication with the vision sensor (%s). (%s: 2-digit hexadecimal number that determines the error details)
		Countermeasure	140: The license authentication result is invalid. Refer to No. 9 in "14.5 Q&A" No. for troubleshooting. * Authentication error does not occur when the V3Open or V3Close command is executed.

14.3.MELFA Smart Plus Card Related Error Details

Table 14-3 MELFA Smart Plus card related error details

Error No.	Error cause and countermeasure	
L3780	Error message	Cannot use the MELFA Smart Plus.
	Cause	The MELFA Smart Plus card or MELFA Smart Plus card pack is inserted. If the MELFA Smart Plus card is inserted, the value of the parameter SMART+1 is not set correctly.
	Countermeasure	Insert the MELFA Smart Plus card or MELFA Smart Plus card pack. Set the value of the parameter SMART+1 correctly.
L3781	Error message	Cannot use the MELFA Smart Plus.
	Cause	The MELFA Smart Plus card or MELFA Smart Plus card pack is inserted. If the MELFA Smart Plus card is inserted, the value of the parameter SMART+1 is not set correctly.
	Countermeasure	Insert the MELFA Smart Plus card or MELFA Smart Plus card pack. Set the value of the parameter SMART+1 correctly.
L3782	Error message	Multiple MELFA Smart Plus cards are inserted.
	Cause	Multiple MELFA Smart Plus cards are inserted.
	Countermeasure	Turn OFF the controller power, and remove the unnecessary MELFA Smart Plus cards.

14.4.MELFA-3D Vision Error Code Details

The MELFA-3D Vision error codes are stored in the status variable M_V3Rslt or displayed in the error message on the MELFA-3D Vision window of RT ToolBox3.

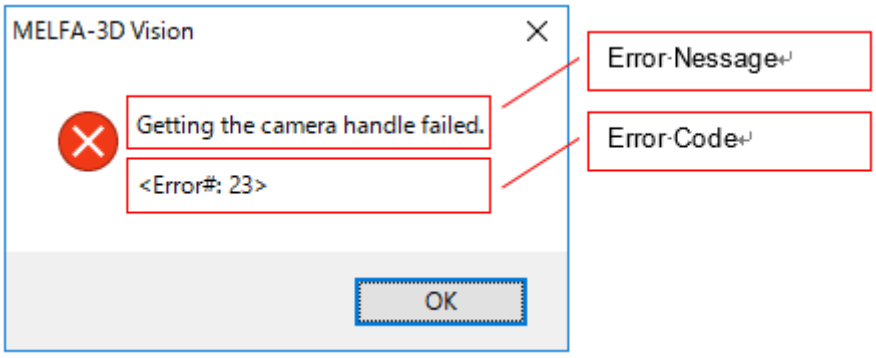


Fig. 14-2 Error message and error code

■ General error

Error code	Error cause and countermeasure	
3	Error message	The value is outside of range.
	Cause	The setting value is outside the range.
	Countermeasure	Change the setting value.
4	Error message	Defined the same name.
	Cause	The names are duplicated.
	Countermeasure	Change the names.
7	Error message	Recognition is failed.
	Cause	Recognizing the calibration mark failed.
	Countermeasure	Adjust the position of the calibration mark so that it is within the recognition range.
9	Error message	It is used by other job.
	Cause	The measurement/recognition processing is being performed.
	Countermeasure	Wait until the measurement/recognition processing of other jobs is completed.
10	Error message	Data is full.
	Cause	The workpiece size exceeds the upper limit.
	Countermeasure	Change the workpiece model.
11	Error message	The mode does not match. Confirm the mode.
	Cause	The operation mode is not correct.
	Countermeasure	Change the operation mode.
15	Error message	Creating folder failed.
	Cause	Creating a system folder failed.
	Countermeasure	Increase the free space in the Documents folder of the user and lower. Or, check the access right of the Documents folder.
21	Error message	IP address is not set.
	Cause	The camera's IP address is not set.
	Countermeasure	Set the camera's IP address.
22	Error message	Setup of IP address failed.
	Cause	Setting the camera's IP address failed.

Error code	Error cause and countermeasure	
	Countermeasure	Check the connection status with the camera head. Turn ON the camera head power again.
23	Error message	Getting the camera handle failed.
	Cause	Getting the camera handle failed. The camera may be used in other control units.
	Countermeasure	Turn ON the camera head power again.
25	Error message	Getting the image size failed.
	Cause	The connection with the camera is not open.
	Countermeasure	Check the connection status between the power cable and the communication cable of the camera head.
26	Error message	Getting the image failed.
	Cause	There is a problem with the connection among the control unit, camera, and projector.
	Countermeasure	Check the connection status between the control unit and the camera head.
27	Error message	Invalid image.
	Cause	Measurement data is not in the workspace.
	Countermeasure	Execute the job after measurement.
31	Error message	Connecting to the robot failed.
	Cause	The robot communication settings are not performed. Or, the communication line with the robot is not connected.
	Countermeasure	Check the robot communication settings (*1) and connection status (*2). (*1): IP address, port number (*2): LAN cable, switching hub
32	Error message	Sending to the robot failed.
	Cause	The robot communication settings are not performed. Or, the communication line with the robot is not connected.
	Countermeasure	Check the robot communication settings (*1) and connection status (*2). (*1): IP address, port number (*2): LAN cable, switching hub
100	Error message	A mismatch has occurred in the measurement parameter settings.
	Cause	The measurement parameter settings before and after selecting [Do not measure] differ.
	Countermeasure	Note that the following settings differ depending on whether the [Measure] button is pressed with or without selecting the [Not capture] check box. ・The "Flex View Shifting" value of the ENSENSO measurement parameters (Refer to "8.2.1 ENSENSO measurement parameter settings".)
101	Error message	Initialization failed. Please set the communication with the camera again or restart MELFA-3D Vision.
	Cause	There was a problem during initialization.
	Countermeasure	Configure the camera communication settings or restart MELFA-3D Vision.
102	Error message	Failed to disconnect the camera.
	Cause	Failed to disconnect camera communication.
	Countermeasure	Check the status of connection with the camera.
103	Error message	Failed to open the camera.
	Cause	Not connected to the camera.
	Countermeasure	Check the connection with the camera.
104	Error message	Imaging failed.
	Cause	There is a problem connecting to the camera.
	Countermeasure	Check the connection with the camera.

Error code	Error cause and countermeasure	
105	Error message	Failed to generate range image.
	Cause	At the time of measurement, generation of the range image failed.
	Countermeasure	Check the connection with the camera.
106	Error message	The camera connection information is different from the set value.
	Cause	The camera settings and the actual information are different.
	Countermeasure	Check the values set on the "Camera setting" screen.
107	Error message	The connection with the camera has timed out.
	Cause	The connection with the camera has timed out.
	Countermeasure	Check the connection with the camera.
110	Error message	A memory error has occurred.
	Cause	An error occurred while reading or writing memory.
	Countermeasure	Contact the manufacturer.
111	Error message	Unregistered error.
	Cause	An unregistered error has occurred.
	Countermeasure	Contact the manufacturer.
112	Error message	Over temperature of the camera has occurred.
	Cause	The camera temperature is too high.
	Countermeasure	If an overtemperature error has occurred, immediately stop the power supply to the camera, lower the ambient temperature, and reconnect the camera.
140	Error message	The activation error has failed.
	Cause	Failed to detect the activation dongle.
	Countermeasure	Ensure that the license USB dongle is connected to the control unit. * Authentication error does not occur when the V3Open or V3Close command is executed.

■ Model matching recognition related error

Error code	Error cause and countermeasure	
41	Error message	Failed to detect edge information for pose estimation.
	Cause	The edge information necessary for recognition was not detected.
	Countermeasure	Adjust the value of the edge extraction parameter.
43	Error message	The number of sampling points for pose estimation is too little.
	Cause	The number of sampling points necessary for recognition could not be obtained.
	Countermeasure	Adjust the value of the boundary point sampling interval. Register the workpiece model again.
44	Error message	The number of extracted features for pose estimation is too numerous.
	Cause	Since the memory is insufficient, the number of the extracted features exceeds the upper limit.
	Countermeasure	Adjust the value of the boundary point sampling interval. Register the workpiece model again.
45	Error message	No pose estimation result.
	Cause	No posture candidates were found.
	Countermeasure	Adjust the recognition parameter. Increase the upper limit of the number of initial candidates.
46	Error message	Alignment error between a CAD model and 3D scan data is too large.
	Cause	The posture candidates were found, but the recognition error is too large.
	Countermeasure	Adjust the recognition parameter.
47	Error message	Registered model is invalid.
	Cause	The registered workpiece model data is damaged.
	Countermeasure	Register the workpiece again.

■ System related error

Error code	Error cause and countermeasure	
50	Error message	The Control Unit is in operation.
	Cause	The measurement/recognition processing is being performed.
	Countermeasure	Wait until the measurement/recognition processing of other jobs is completed.
1001	Error message	Failed in startup the projector. There is the prospect of the failure. Please contact the manufacturer.
	Cause	Starting the projector failed.
	Countermeasure	Turn ON the camera head power again. The MELFA-3D Vision may be damaged. Contact the manufacturer.
1003	Error message	It does not match the version of MELFA-3D Vision.
	Cause	The versions of MELFA-3D Vision and RT ToolBox3 do not match.
	Countermeasure	Check the software version, and install RT ToolBox3 or the MELFA-3D Vision software again.

■ Communication related error

Error code	Error cause and countermeasure	
2001	Error message	The communication with the camera head is failed. Please set the communication with the camera again or restart MELFA-3D Vision.
	Cause	The connection with the camera head is not open. (Camera handle error)
	Countermeasure	Check the connection status with the camera head. Then, configure the camera communication settings or restart MELFA-3D Vision.
2002	Error message	The camera parameter setting is outside of range.
	Cause	Setting the camera parameter failed.
	Countermeasure	Check the value of the camera parameter.
2003	Error message	The imaging is failed.
	Cause	There is a problem with the communication between the camera and the projector.
	Countermeasure	The MELFA-3D Vision may be damaged. Contact the manufacturer.
2004	Error message	There is no response from the projector.
	Cause	There is a problem with the communication between the camera and the projector.
	Countermeasure	The MELFA-3D Vision may be damaged. Contact the manufacturer.

■ Calibration related error

Error code	Error cause and countermeasure	
3101	Error message	Robot calibration has not been implemented.
	Cause	The robot calibration has not been completed.
	Countermeasure	Perform the robot calibration.
3102	Error message	Data cannot be registered because the number of registered data has been exceeded.
	Cause	The number of registered data exceeds the upper limit.
	Countermeasure	After deleting the unnecessary registered data, register data.
3104	Error message	Calibration data is not selected.
	Cause	The calibration data is not selected.
	Countermeasure	Select the calibration data.
	Cause	The robot's initial position or marker position is unfavorable.
	Countermeasure	Check the robot's initial position or marker position.

■ MELFA Smart Plus function related error

Error code	Error cause and countermeasure	
3780	Error message	Cannot use the MELFA Smart Plus.
	Cause	The MELFA Smart Plus card or MELFA Smart Plus card pack is inserted. If the MELFA Smart Plus card is inserted, the value of the parameter SMART+1 is not set correctly.
	Countermeasure	Insert the MELFA Smart Plus card or MELFA Smart Plus card pack. Set the value of the parameter SMART+1 correctly.
3781	Error message	Cannot use the MELFA Smart Plus.
	Cause	The MELFA Smart Plus card or MELFA Smart Plus card pack is inserted. If the MELFA Smart Plus card is inserted, the value of the parameter SMART+1 is not set correctly.
	Countermeasure	Insert the MELFA Smart Plus card or MELFA Smart Plus card pack. Set the value of the parameter SMART+1 correctly.

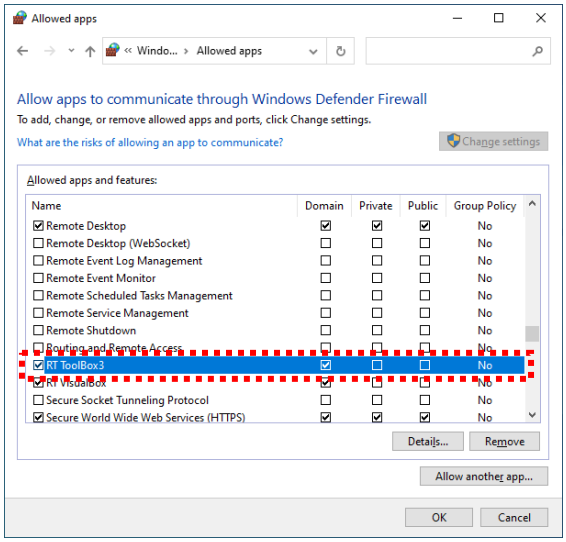
■ MELFA Smart Plus AI (MELFA-3D Vision extended) function related error

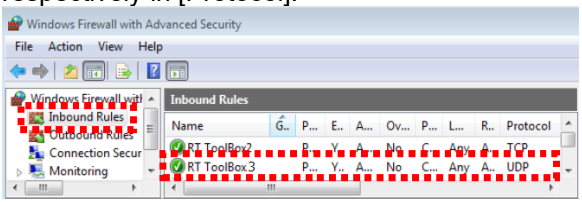
Error code	Error cause and countermeasure	
4001	Error message	Cannot start a bulk simulator.
	Cause	Starting the bulk simulator failed. Or, the bulk simulator is not started correctly.
	Countermeasure	Close the automatic adjustment screen once, and start the simulator again.
4002	Error message	Cannot close the bulk simulator
	Cause	Closing the bulk simulator failed.
	Countermeasure	If the PhysicalSim.exe process remains when Task Manager is open, close the task.
4003	Error message	Cannot run a parameter optimization.
	Cause	The parameter automatic adjustment processing failed.
	Countermeasure	Close the automatic adjustment screen once, and perform the parameter automatic adjustment processing again. Change the workpiece model and learning environment setting, and perform the parameter automatic adjustment processing again.
4006	Error message	Failed to register a work model.
	Cause	Registering the workpiece model failed.
	Countermeasure	Close the automatic adjustment screen once, and register the workpiece model again.
4007	Error message	Failed to delete the work model.
	Cause	Deleting the workpiece model failed.
	Countermeasure	Close the automatic adjustment screen once, and register the workpiece model again.
4008	Error message	Failed to calculate the center of gravity of the work model.
	Cause	Calculating the center of gravity of the workpiece model failed.
	Countermeasure	Close the automatic adjustment screen once, and calculate the center of gravity of the workpiece model again.
4009	Error message	The memory for the bulk simulator was insufficient. Close the automatic adjustment screen.
	Cause	Since the memory is insufficient, the automatic adjustment could not be performed with the specified workpiece model and learning environment.
	Countermeasure	Change to a simple shape workpiece model. Reduce the number of workpieces in the learning environment setting. Check that the computer performance meets the request specifications.

■ Setting related error

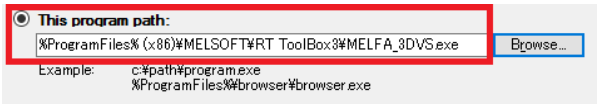
Error code	Error cause and countermeasure	
6001	Error message	It is in use on the jobs.
	Cause	Because the name is in use on the jobs, it cannot be changed.
	Countermeasure	Deselect the job, and change the name.
6002	Error message	It is in use on the work lists.
	Cause	Because the name is in use in the workpiece list, it cannot be changed.
	Countermeasure	Deselect the name in the workpiece list, and change the name.
6003	Error message	The hand is not selected.
	Cause	The hand is not selected.
	Countermeasure	Select the hand.

14.5.**Q&A**

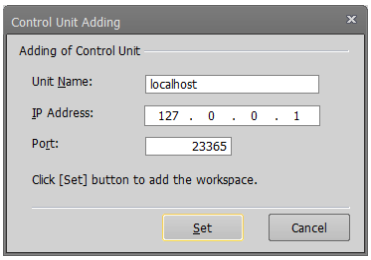
<table>
<tr><th>No.</th><th>Symptom</th><th>Cause</th><th>Measure</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">The control unit is powered on, but it is not displayed on the Setting and Add Control Unit screen.</td><td>The application is not started.</td><td>Check that the application is started.</td></tr>
<tr><td>The LAN cable may be disconnected or may be damaged.</td><td>Check the LAN cable.</td></tr>
<tr><td>Communication has been blocked by the firewall.</td><td>Select [Control Panel] - [System and Security] - [Allow an app through Windows Firewall], click the [Change settings] button, followed by the [Allow another app...] button, and specify the installation destination to add it.
Installation destination for the RT ToolBox3 (default)
C:\Program Files(x86)\MELSOFT\RT ToolBox3\MELFA_3DVS.exe
Select the "Domain", "Home/Work (Private)", or "Public" check box based on the usage environment, and then click the [OK] button.
 

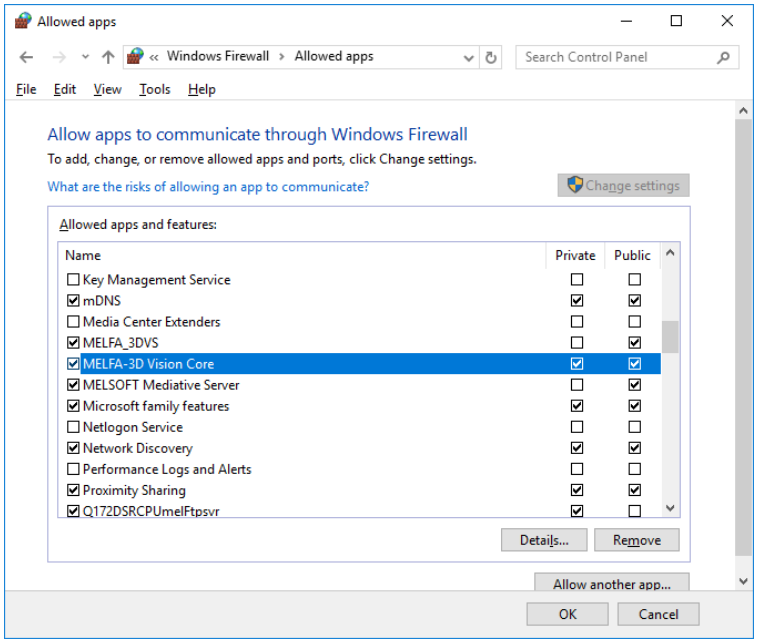
Select [Control Panel] - [System and Security] - [Windows Firewall] - [Advanced].
On the following screen, select [Inbound Rules], then confirm that there is "RT ToolBox3", and "TCP" and "UDP" are selected respectively in [Protocol].
 

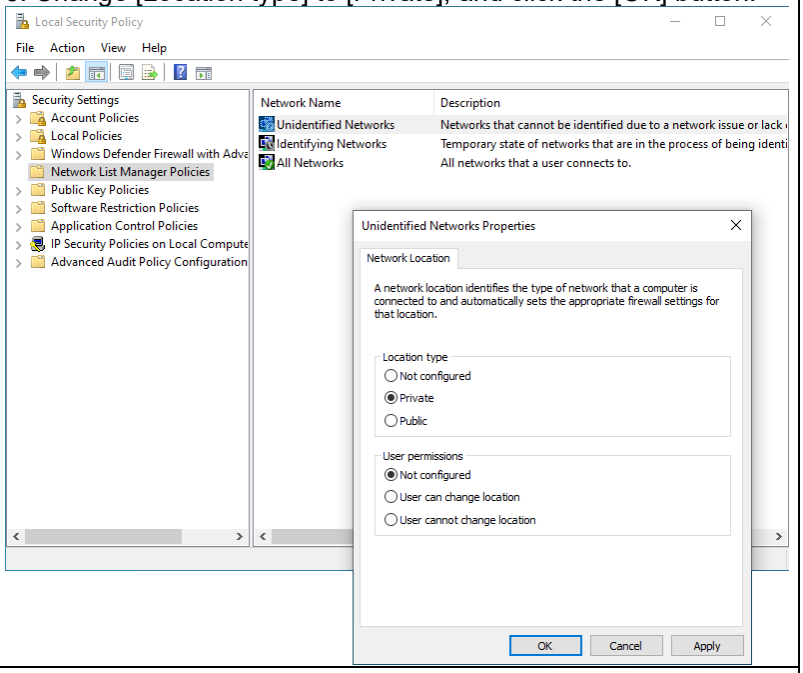
* When the port input for UDP is not admitted:
Select [New rule] from the above mentioned screen and start the new inbound rule wizard.
Configure the settings as follows in each step of the wizard.
<Step: Rule types>
Select [Custom] and then click [Next].
<Step: Program>
Select [This program path], then configure the execution file for "RT ToolBox3".</td></tr>
</table>

<table>
<tr><th>No.</th><th>Symptom</th><th>Cause</th><th>Measure</th></tr>
<tr><td></td><td></td><td></td><td>%Program Files (x86)\MELSOFT\RT ToolBox3\
MELFA_3DVS.exe
 

<Step: Protocol and port>
Select [UDP] under [Protocol types].
<Step: Scope>
Under the initial settings, click [Next].

<Step: Operation>
In the state in which [Allow the connection] is selected, click [Next].
<Step: Profile>
Confirm the settings in accordance with your network settings.
<Step: Name>
Input "RT ToolBox3" into [Name], then click the [Complete] button.</td></tr>
<tr><td></td><td></td><td>Communication has been blocked by the anti-virus software.</td><td>Refer to the manual for the relevant product and specify communication permission settings for the installation destination in the firewall settings.
Installation destination for the RT ToolBox3 (default)
C:\Program Files (x86)\MELSOFT\RT ToolBox3\
MELFA_3DVS.exe</td></tr>
<tr><td></td><td></td><td>When installing to the same computer as RT ToolBox3: The computer is not connected to the switching hub.</td><td>Add the control unit manually.
1. Click the [Manual addition] button on the Setting and Add Control Unit window.
2. Set the local loopback address (127.0.0.1) for IP Address in the Control Unit Adding window, and click the [Set] button.
 
</td></tr>
<tr><td>2</td><td>The control unit is powered on, but double-clicking the unit added to the workspace does not display the MELFA-3D Vision setting screen.</td><td>Same as No.1</td><td>Same as No.1</td></tr>
</table>

No.	Symptom	Cause	Measure
3	V3Open was executed, but an L3142 error occurred, and it is not possible to connect to the control unit.	The subnet mask setting for the IP address set at the control unit setting/addition screen differs from the IP address set in the robot Ethernet settings.	Ensure that the part in the IP address "□□□-□□□-□□□-ΔΔΔ" is same for both the control unit and robot.
		The port No. set at the control unit setting/addition screen differs from that set in the robot Ethernet settings.	Enter the same port No. in the robot Ethernet settings as that set for the control unit.
		The COM No. specified with V3Open is incorrect.	Check the specified COM No.
		The LAN cable is damaged or not connected.	Check the LAN cable.
		The MELFA-3D Vision application has been blocked by the firewall.	Go to [Control Panel] → [Windows Firewall], then click [Allow an app or feature through Windows Firewall]. Click the [Change settings] button, select MELFA-3D Vision, and select the "Domain"/"Private"/"Public" check box based on the usage environment, and then click the [OK] button.  When the problem cannot be resolved by the above measures:

No.	Symptom	Cause	Measure
			(Ex. When connection is performed via the local network) 1. Input the [Win] + R key, enter "secpol.msc", and click the [OK] button to open the Local Security Policy window. 2. Select [Network List Manager Policies], and double-click [Unidentified Networks] displayed in the right pane. 3. Change [Location type] to [Private], and click the [OK] button. 
4	V3Open was executed, but an L8610 error occurred, and it is not possible to connect to the control unit.	The LAN cable is damaged or not connected.	Check the LAN cable.
5	V3Open was executed, but an L8632 error occurred, and it is not possible to connect to the control unit.	There is no response from the edge computer.	Ensure that the port No. at the edge computer "Robot communication settings" screen (see Fig. 6-9) is set for any of the port Nos. at the robot controller "Ethernet settings" screen (see Fig. 6-27).
6	An error occurred after executing V3Run. What the error number indicates is not clear.		Refer to "M_V3Rslt" in "12.2 MELFA-3D Vision Related Status Variables".
7	When the Ready signal output is set, error 4320 occurs with the robot controller.	This is because cycles are fixed in the IO processing mode.	Change the IO processing mode to the high-speed mode (change the parameter "SYNCIO" of the robot controller to 1 or 2).
8	An overtemperature error occurs.	The temperature inside the camera is too high.	Lower the ambient temperature and reconnect the camera.

No.	Symptom	Cause	Measure
9	L8690 99000 Vision communication status error [Cause]: [An error has occurred in communication with the vision sensor (140).] occurs.	The MELFA-3D Vision software license authentication has failed.	Check if the USB device is properly inserted into the control unit. License authentication may fail under the following cases. Check all of the following cases, and restart MELFA-3D Vision software. • Immediately after power ON/OFF • At a restart • Immediately after login/logoff/user switching • Immediately after entering in standby/pause/sleep mode, and immediately after wake-up from standby/pause/sleep mode • Immediately after connecting the USB device to the personal computer
10	The robot stops during non-contact type robot calibration.	Either of the following is applicable. 1. The robot was stopped during calibration and the calibration was restarted from a position different from the stop position (M_V3Rlst(x) = 33 (x: Storage destination No.) 2. Marker recognition failed during calibration.	For cause 1. ■ Possible causes 1. An error indicating that the robot is outside the operating range has occurred. 2. The robot was stopped and restarted from a position different from the stop position. 3. The robot is operated in a position where the multi-rotation flag or structure flag is switched. 4. The override is so high that the robot vibrates. 5. Tool was overwritten in a While statement of the created calibration program. ■ Solutions to the possible causes mentioned above 1. Perform calibration within the operating range of the robot. 2. Move the robot back to its initial position and perform calibration from the beginning. 3. Operate the robot in a position where the multi-rotation flag or structure flag is not switched. 4. Reduce the override value, then perform calibration. 5. Do not execute the Tool command in a While statement of the created calibration program. For cause 2. After checking the following, move the robot to the initial position and perform the program from the start. • Are the settings of "Initial setting" and "Pattern setting" correct? • Are all the markers within the angle of view? • Is there any invisible marker due to black or white clipping? M_V3Rslt(x) (x: Storage destination No.) 3105 → Marker recognition failed during calibration (X direction in the tool coordinates). 3106 → Marker recognition failed during calibration (Y direction in the tool coordinates). 3107 → Marker recognition failed during calibration (Z direction in the tool coordinates). 3108 → Marker recognition failed during calibration (A direction in the tool coordinates). 3109 → Marker recognition failed during calibration (B direction in the tool coordinates). 3110 → Marker recognition failed during calibration (C direction in the tool coordinates).
11	Error 103 still occurs even after the camera communication settings are	The firmware version of the camera is not correct.	Go to [Start menu] → [EnsensoSDK] → [NxView], then update the firmware of the camera. For information on how to operate NxView, refer to "14.5.1 Inquiries regarding ENSENSO cameras and accessories".

No.	Symptom	Cause	Measure
	configured correctly.		
12	Communication with the camera cannot be established.	The LAN cable is not connected or broken. Or communication with the camera is interrupted due to reasons such as sleep mode of the control unit.	Check the LAN cable, and establish communication with the camera again by referring to "6.2.2.1 Camera communication settings". Restart the MELFA-3D Vision application.

14.5.1. Inquiries regarding ENSENSO cameras and accessories

MELFA-3D Vision 3.0 is compatible with the following cameras. For inquiries regarding each camera and accessory, contact the following IDS Imaging Development Systems GmbH support representatives.

Table 14-4: MELFA-3D Vision 3.0-compatible camera models and recommended accessories

Supported camera models	Calibration plate/pattern	Recommended PoE LAN cable
ENSENSO-N35 ENSENSO-N36 The following website allows you to check the specifications by selecting the N36 series camera best suitable for the working distance and field of view being used. N35 series cameras are no longer in production. https://en.ids-imaging.com/ensenso-selector.html	The following website allows you to check the specifications by selecting the camera being used. https://en.ids-imaging.com/ensenso-selector.html	AD00268

[Inquiries regarding ENSENSO cameras]
IDS Imaging Development Systems GmbH support representatives
e-mail: apacsales@ids-imaging.com
TEL: +81 3 4500 8864
Branch/Office address:
IDS Imaging Co., Ltd.
3F, Mita Nexus Building, 1-3-33 Mita, Minato-ku
108-0073 Tokyo
Japan

15. APPENDIX

15.1. Ready signal settings

Once the Ready signal is set, a signal indicating that the control unit is running can be output from the specified robot. Using 8 bits from the specified signal, it counts in 1-second intervals (0 to 255).
It is used to monitor the status of the controller unit (completion of startup, end, etc.) from other external devices.

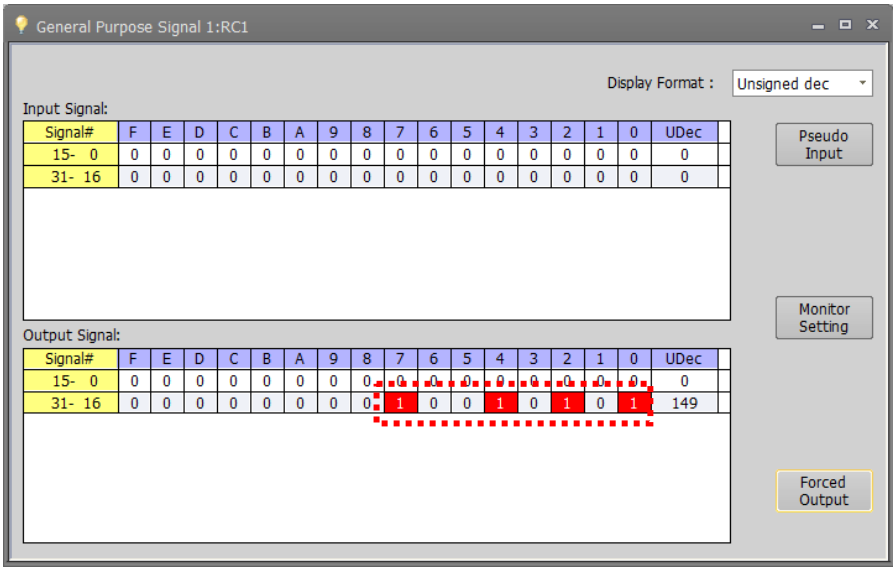


Fig. 15-1 Example of using the Ready signal

When specifying the Ready signal, click [Set ready signal] in the context menu, which appears by right-clicking the subject robot on the [Robot] tab from the property monitor.
On the displayed settings screen, enter the first signal number allocated to the Ready signal. Enter "-1" in order to turn off the Ready signal. Clicking [Set] enters the settings of the Ready signal in the controller unit.

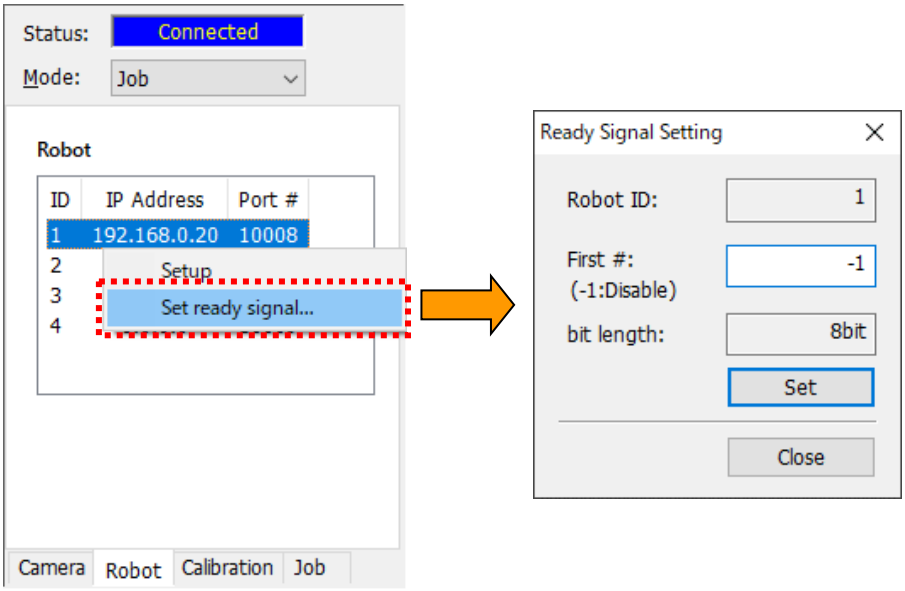


Fig. 15-2 Ready signal settings screen

◇◆◇When error4320 occurs◇◆◇
When error 4320 occurs with a robot controller after the Ready signal setting, refer to No.10 of 10.5 Q&A.

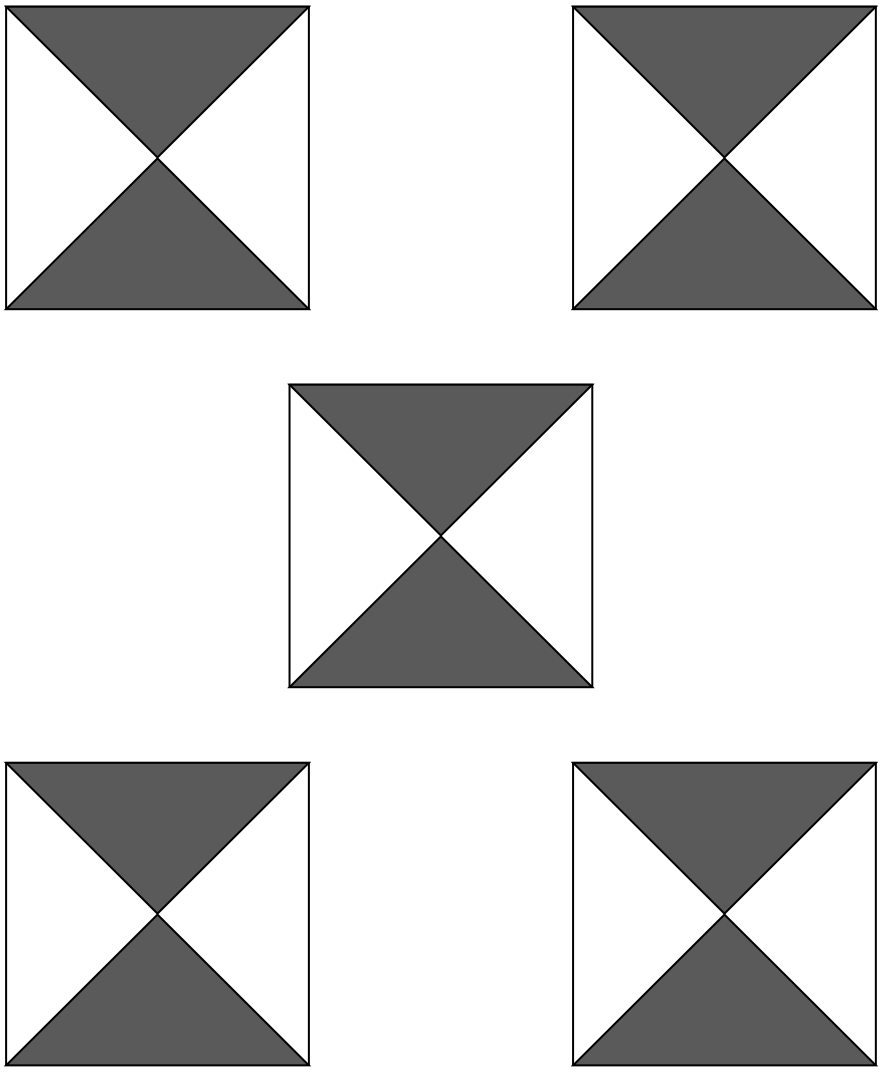
15.2.**Robot Calibration Program**

```
'【Declaration of variables, acquisition of the current tool position】
PTL = P_Tool
'【Connects to MELFA-3D Vision】
V3Close
If M_Open(2) <> 2 Then              'If the vision sensor No.2 is not available
   V3Open "COM2:" As #2             'Connects to a vision sensor which uses COM2 and names it as #2
EndIf
Wait M_Open(2) = 2                  'Connects to the vision sensor No.2 and wait for it to be available
If M_Ovrd > 10 Then
   Ovrd 10                          'Saturates ovrerride to 10%
EndIf
'【Recognizes the robot calibration plate】
Mov PCAP                            'Moves to the initial position; the marker is at the center of the ROI
MOK=0
Dly 3                               'Waits until the robot settels down
While MOK=0                         'Repeats “V3Calib” until whole the robot calibration is finished
      V3Calib #2,1,1                'Executes the robot calibration
      *LP1:If M_V3Rslt(1) = -1 GoTo *LP1      'Waits until “V3Calib” is finished
      If M_V3Rslt(1) = 1 Then MOK=1           'Exits the loop if whole the calibration is finished
         PG_POS = P_V3Pos(1,1) * PTL
         If PosCq(PG_POS)=1 Then Mvs PG_POS
         Dly 0.5
WEnd
Mvs PCAP                            'Goes back to the initial position
V3Close #2                          'Closes the connection
Hlt
End
```

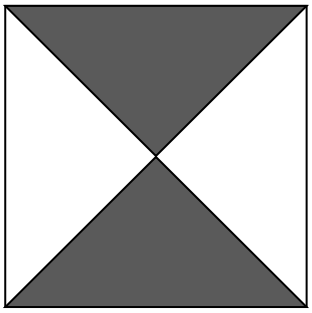
For operation and calibration, it is necessary to execute a program that includes a process to check whether the value of the M_V3Rslt command is normal. If the value is not normal, make sure to solve the problem and execute the program.

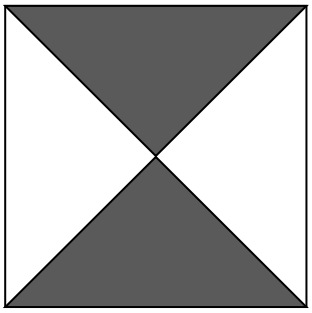
15.3.**Calibration Sheet (For Contact type calibration)**

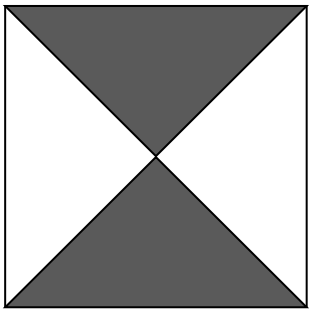
When performing the contact type calibration method, use the sheet as target marks.
Depending on the usage environment (camera field of view size), **enlarge and reduce.**

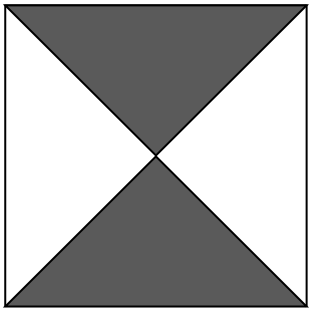


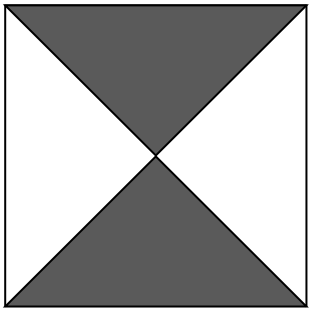
When performing the contact type calibration method, use the sheet as target marks.
Depending on the usage environment (camera field of view size), **enlarge and reduce.**





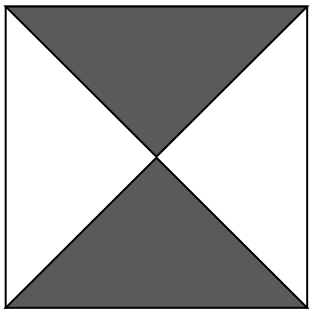






15.4. Calibration Sheet (Non-Contact Type, Robots Other Than Vertical 6-Axis Robots)

Use the sheet as a marker when performing non-contact type calibration for robots other than vertical 6-axis robots.
Increase or decrease the size of the sheet depending on the usage environment (camera's field of view size).



15.5.Other Information

◆About CE Marking

The CE marking on the surface of the product (3F-53U-WINM) casing means that the product is compliant with the EU standards.

Manufacturer : MITSUBISHI ELECTRIC CORPORATION

Address : TOKYO 100-8310, JAPAN
(Place of Declare)

Brand Name :

Authorized representative in Europe (The person authorized to compile the Technical file or relevant Technical documentation)
MITSUBISHI ELCTRIC EUROPE B.V., German Branch Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

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(1-2) 型号的一览

型号
3F-53U-WINM

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基质	×	○	○	○	○	○
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