Canon

Work Support Manual

CANON INDUSTRIAL IMAGING PLATFORM

Vision Edition

"Pick & Place advanced VE141"
(for Denso COBOTTA robot)

[Ver. 1.0]

ENGLISH

Introduction

The purpose of this procedural manual is to help the reader to quickly learn the procedure of pick & place operation using Denso Wave COBOTTA and Canon Vision Edition ver 1.4.1 and later.
Note : [Camera Coordinates Conversion] operation unit to simplify the coordinate conversion is added from Vision Edition ver 1.4.1.
Before applying this procedure to an actual production system, be sure to read and understand the instructions and disclaimer information provided in related software, camera, and industrial robot manuals.

Cautionary notes

⚠ Warning

Personnel or contractors who are involved with the supply or installation of robots must perform a risk assessment on industrial robots that are connected to Canon Industrial Imaging Platform Vision Edition in order to reduce risk to an acceptable level within the scope of their responsibility.

Software versions

Operation methods and the screens used in descriptions might vary depending on the firmware version of the network camera, the version of the operation application, and the software version of Vision Edition.

The following versions are confirmed to work as described in this manual.

Vision Edition	1.4.1
COBOTTA Software Version	2.8.0
WINCAPS3	3.58.0
Virtual TP	1.15 Build 23
Remote TP	1.4.1

"Pick & Place advanced VE141" (for Denso COBOTTA robot) [Ver. 1.0]
Canon Europe Ltd - June 2020

Supplement information for robot setting

Depends on the Denso Wave software version and robot version, complement the differences in the manual.

- **Change (1) Adding a mode lock function**

  A "mode lock function" has been added to restrict the user from switching from normal mode to direct mode/direct preparation mode.

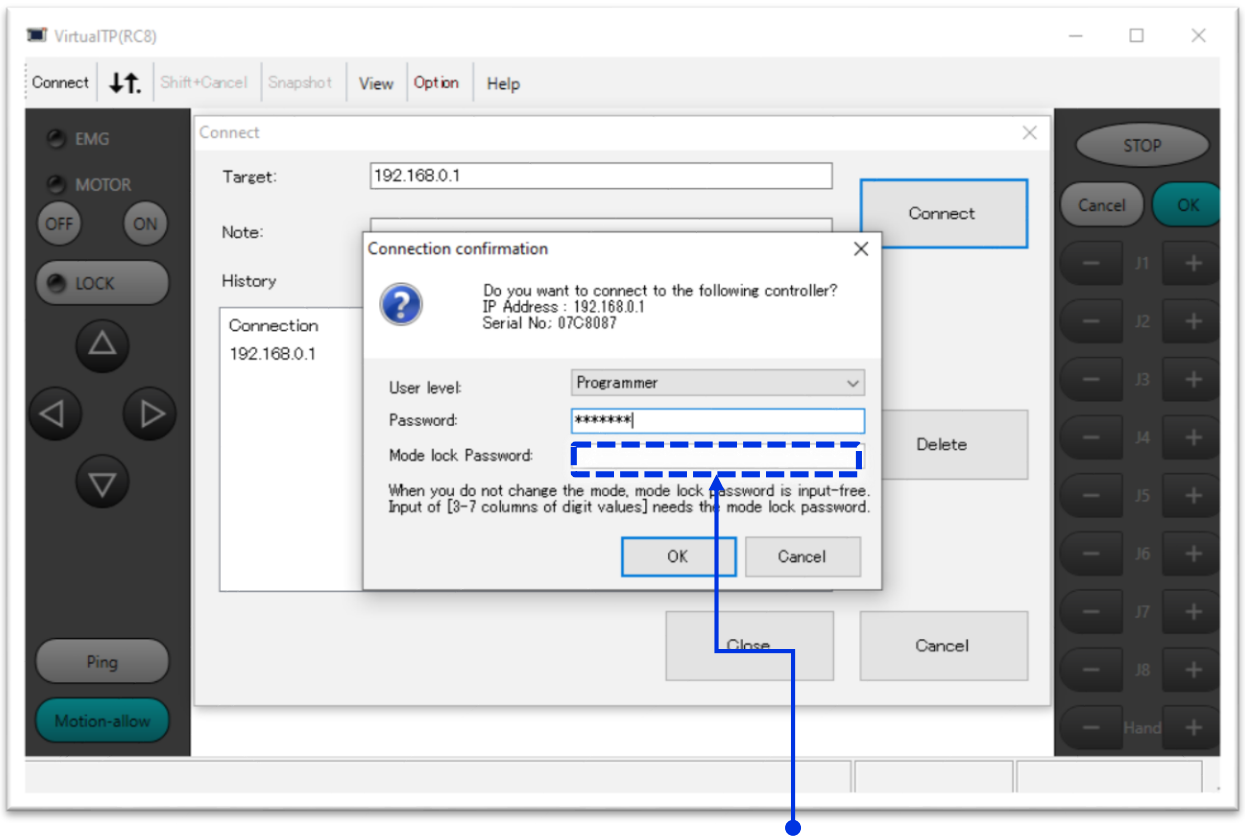
- **Change (2) Setting/Changing the executable token for using Vision Edition**

  With the COBOTTA executable token for TP, it is not possible to use Vision Edition to operate COBOTTA simultaneously.
  Therefore it is necessary to switch the executable token.

(1) Adding a mode lock function

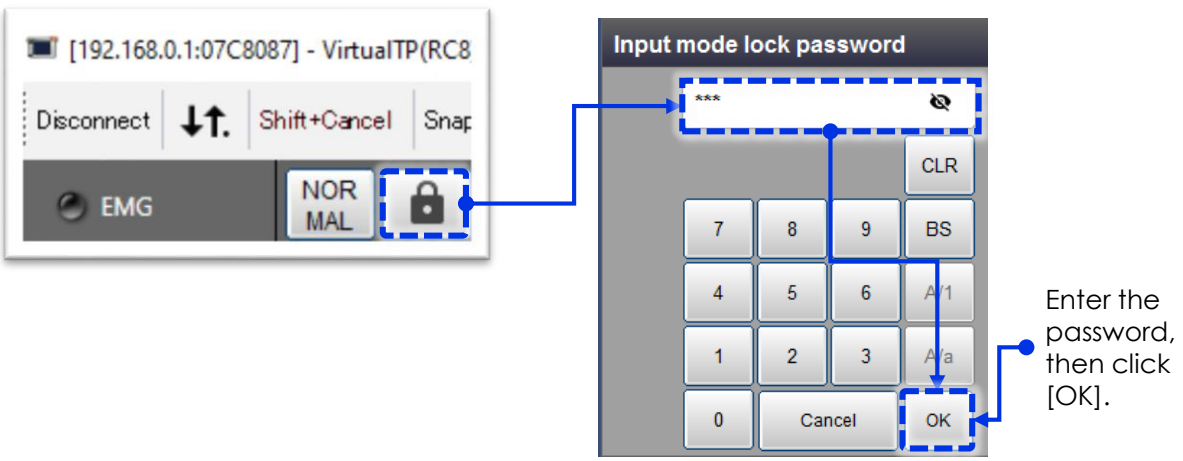
A "mode lock function" has been added to restrict the user from switching from normal mode to direct mode/direct preparation mode. A mode lock password is required to release the mode lock.

1 Set the mode lock password on the login screen.
Create a 3 to 7-digit number of your choice.
* If a mode lock password is not set, mode switching is not possible.



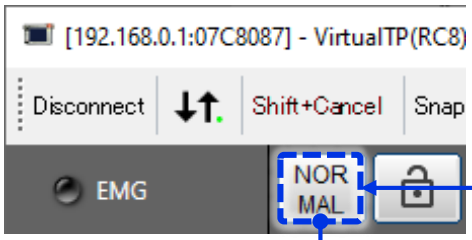
Enter the mode lock password. Set a 3 to 7-digit number of your choice.

2 Click the mode lock icon on the top left side of the screen.
Enter the mode lock password that you set in the previous step.

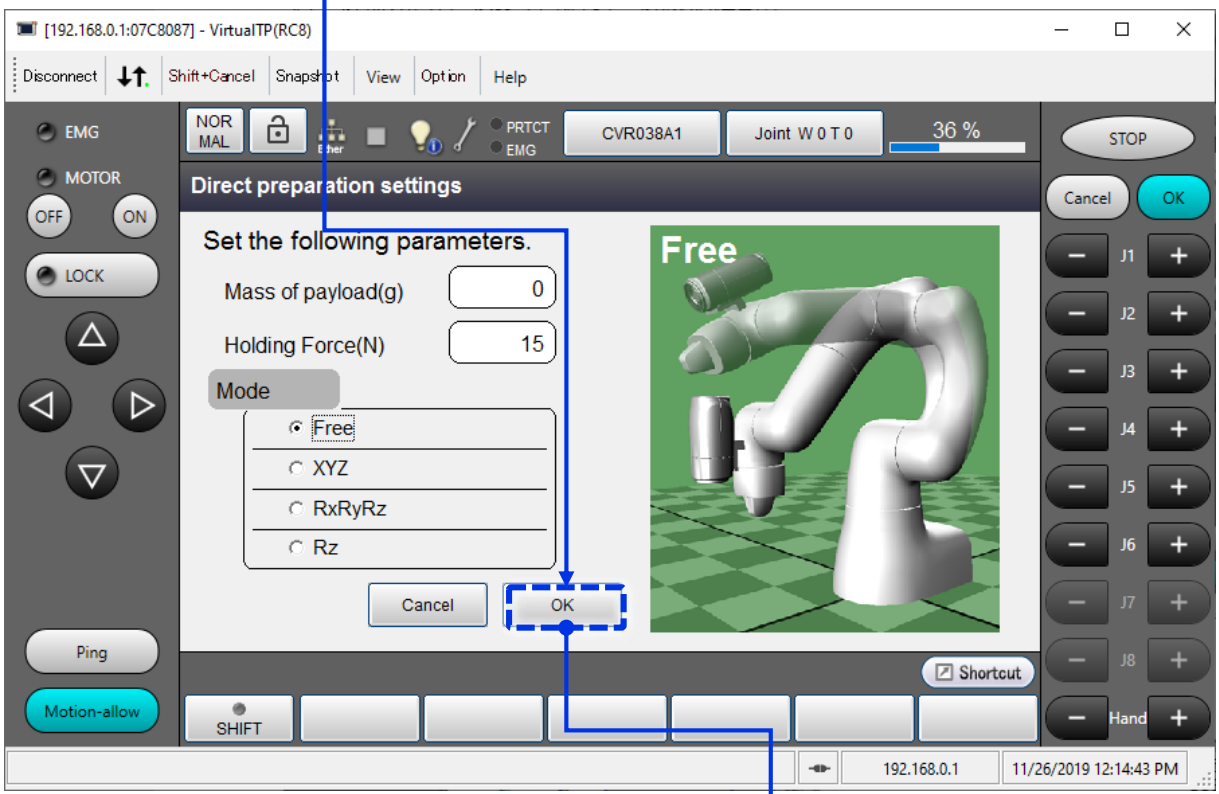


Enter the password, then click [OK].

3 Click [NORMAL], then click [OK] on the screen.
The mode switches to direct preparation mode.

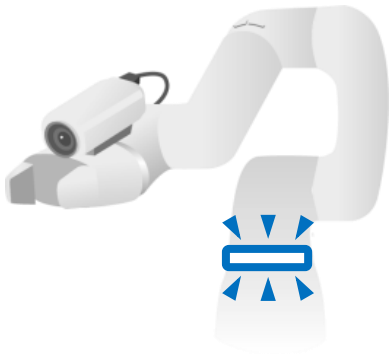


Click [NORMAL].

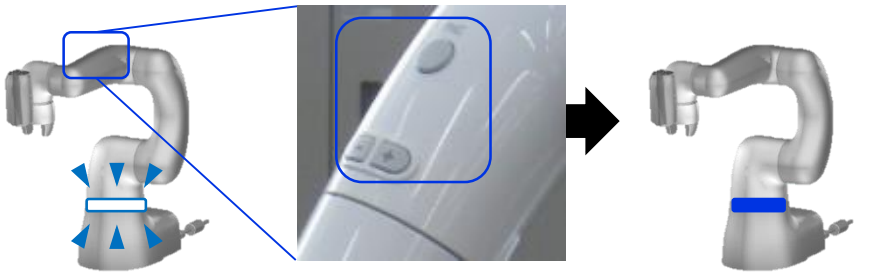


Leave the other settings as is and click [OK].

In direct preparation mode, the robot cannot be operated from TP, etc. In addition, the arm cannot be moved manually.
The light on COBOTTA flashes blue.



4 Press and hold the [FNC] button on COBOTTA's arm for at least 1.5 seconds, to switch to direct mode. The light on COBOTTA illuminates solid blue.
Now, you can move the arm manually.



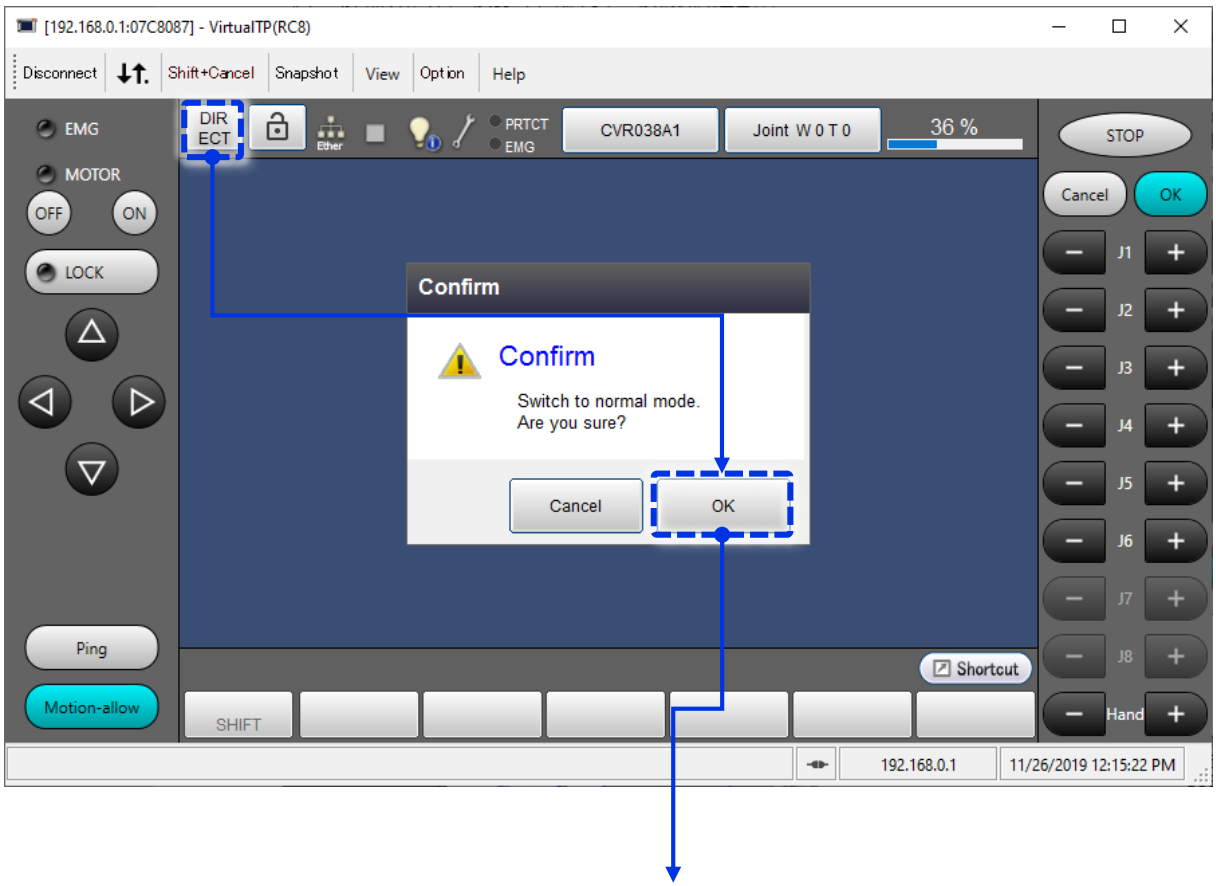
LED flashes blue

Press and hold the [FNC] button for 1.5 seconds

LED illuminates solid blue

5 After moving the robot arm to the desired location, press and hold the [FNC] button on COBOTTA's arm for at least 1.5 seconds once again, to switch to direct preparation mode.

6 Click the [DIRECT] button to switch from direct preparation mode to normal mode.

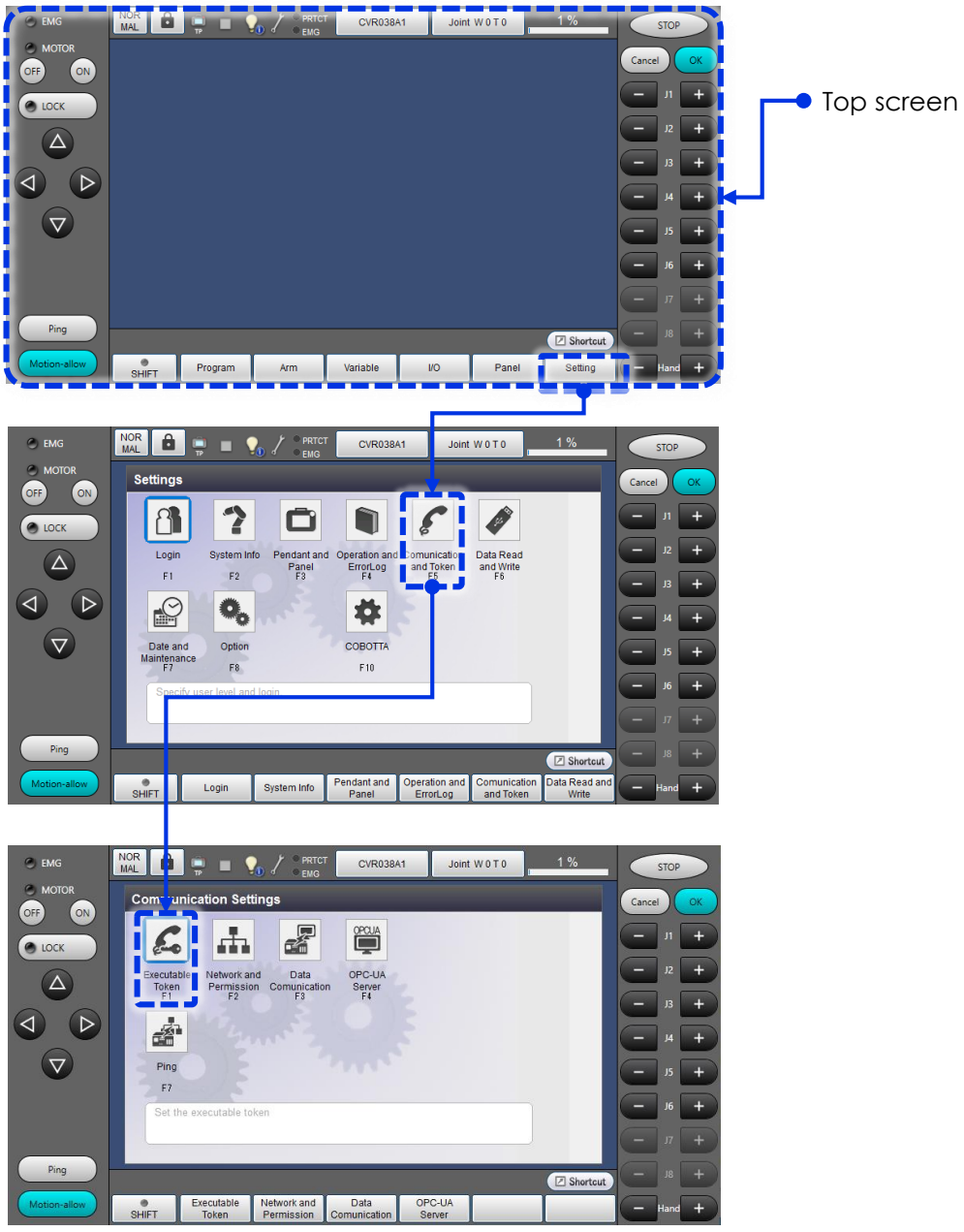


Click [OK].

(2) Setting/Changing the executable token for using Vision Edition

It is not possible to use Vision Edition to operate COBOTTA with the executable token for TP. Therefore, it is necessary to switch the executable token.

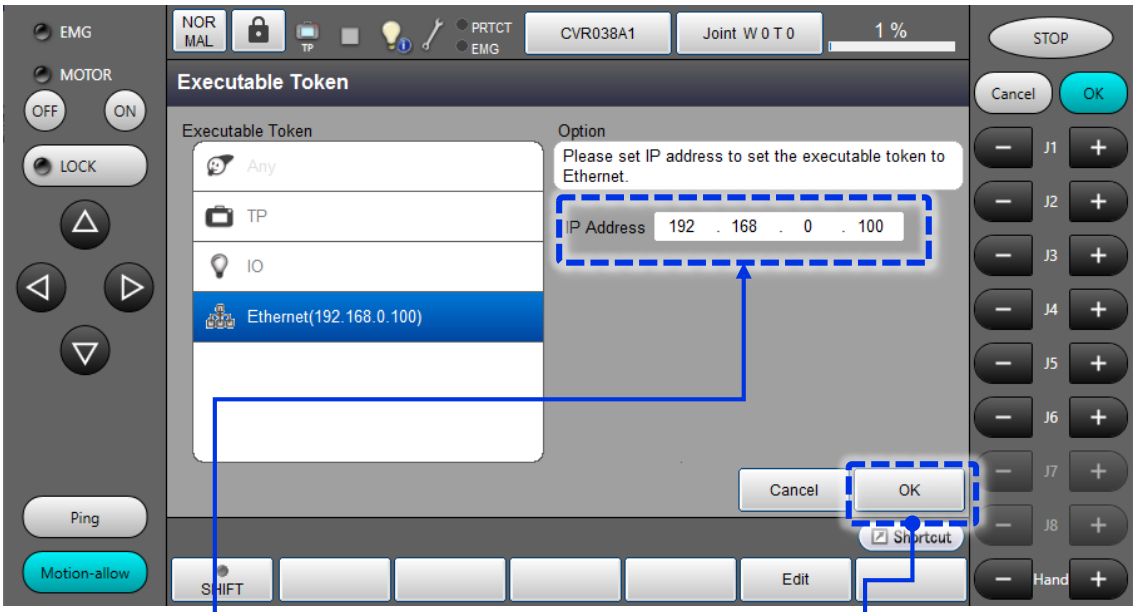
1 From the top screen, select [Setting] ⇒ [Communication and Token] ⇒ [Executable Token], in that order.



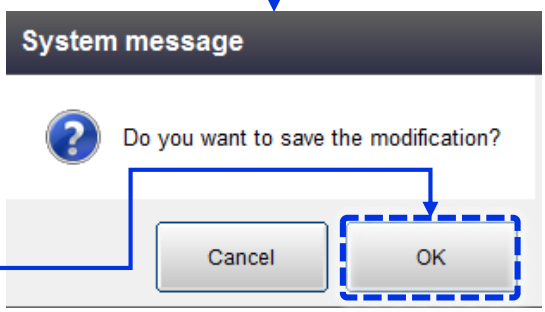
Memo

From any screen, you can click [Cancel] a few times to return to the Top screen.

2 The executable token selection screen is displayed. Select the specified executable token, and click [OK].
To use Virtual TP/Remote TP to operate COBOTTA, select the [TP] executable token.
To use Vision Edition, select the [Ethernet] executable token.



If the token is set to Ethernet, enter the IP address of the Vision Edition IPC and not the computer running Virtual TP unless they are running on the same PC hardware.

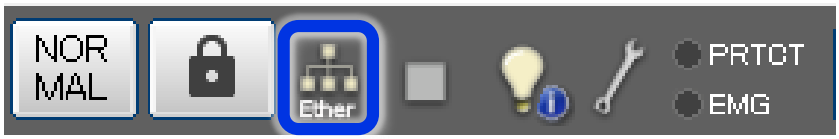


Click [OK].

Note

If the token is set to Ethernet, auto startup of CALSET is not possible and it must be run manually.
For the details of how to run CALSET manually, refer Work Support Manual "Pick & Place basic".
In order to set CALSET to auto startup, it is recommended to change the token to TP before turning off COBOTTA.

3 Confirm that the icon at the top of the pendant screen is the desired mark (Ethernet in this example). (For TP, the icon should be TP.)



Memo

Both direct teaching and speed changes are possible with either the TP or Ethernet executable token.

Chapter 1

Procedure for picking at the desired position

Procedure for picking at the desired position

Note

Before starting this chapter, it is recommended to read and perform the contents of the Work Support Manual "Pick & Place basic" (for Denso COBOTTA robot).
The information provided in this chapter assumes that the reader has read the above manual.

This chapter explains procedure for creating a random pick routine from any pick area within the motion range.

After the robot arm successfully picks the workpiece, it is possible to create a practical program by adding further workflow to this flowchart.

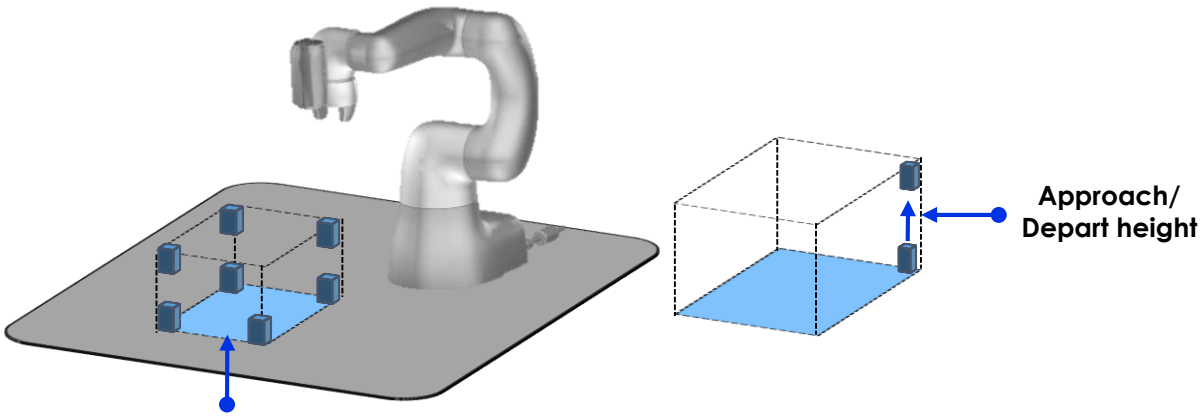
- **Step (1) Checking random pick area not to exceed the robot motion range by TP**
- **Step (2) Setting pick reference position P1 by TP**
- **Step (3) Setting image capture position P0**
- **Step (4) Creating the master image for pattern matching**
- **Step (5) Creating a pattern matching model (NCC)**
- **Step (6) Configure the pattern matching unit**
- **Step (7) Converting the image processing unit coordinate system and the robot coordinate system**
- **Step (8) Setting the robot move destination correction**
- **Step (9) Setting the robot descend movement**
- **Step (10) Setting the robot hand and ascend movement**
- **Step (11) Running the job**

(1) Checking random pick area not to exceed the robot motion range by TP

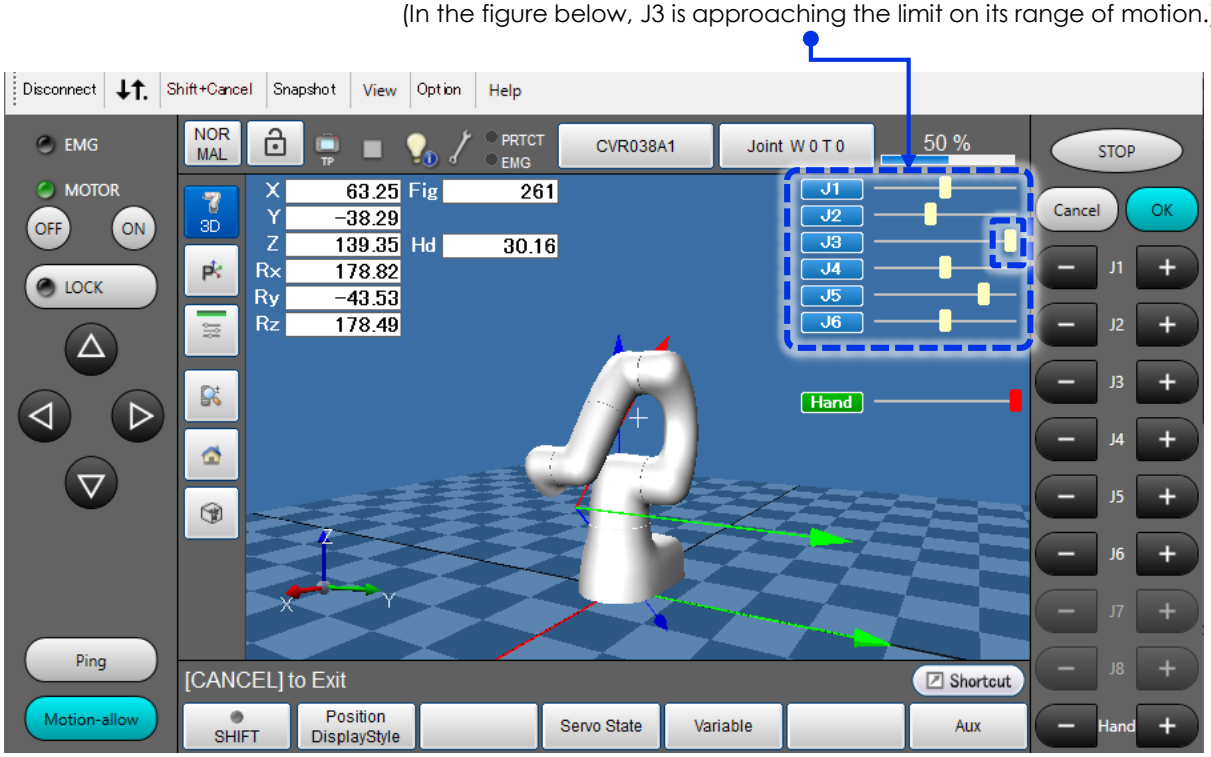
When the robot arm performs pick & place task, need to check if any of the robot's joints exceed the limits of their range of motion. If the limit of motion range is exceeded, a robot error will occur and random pick area need to be revised.

Place COBOTTA in direct mode, and confirm that it can be moved within the expected random pick area without exceeding the limits of motion range. Important points about how the robot should be moved are listed below.

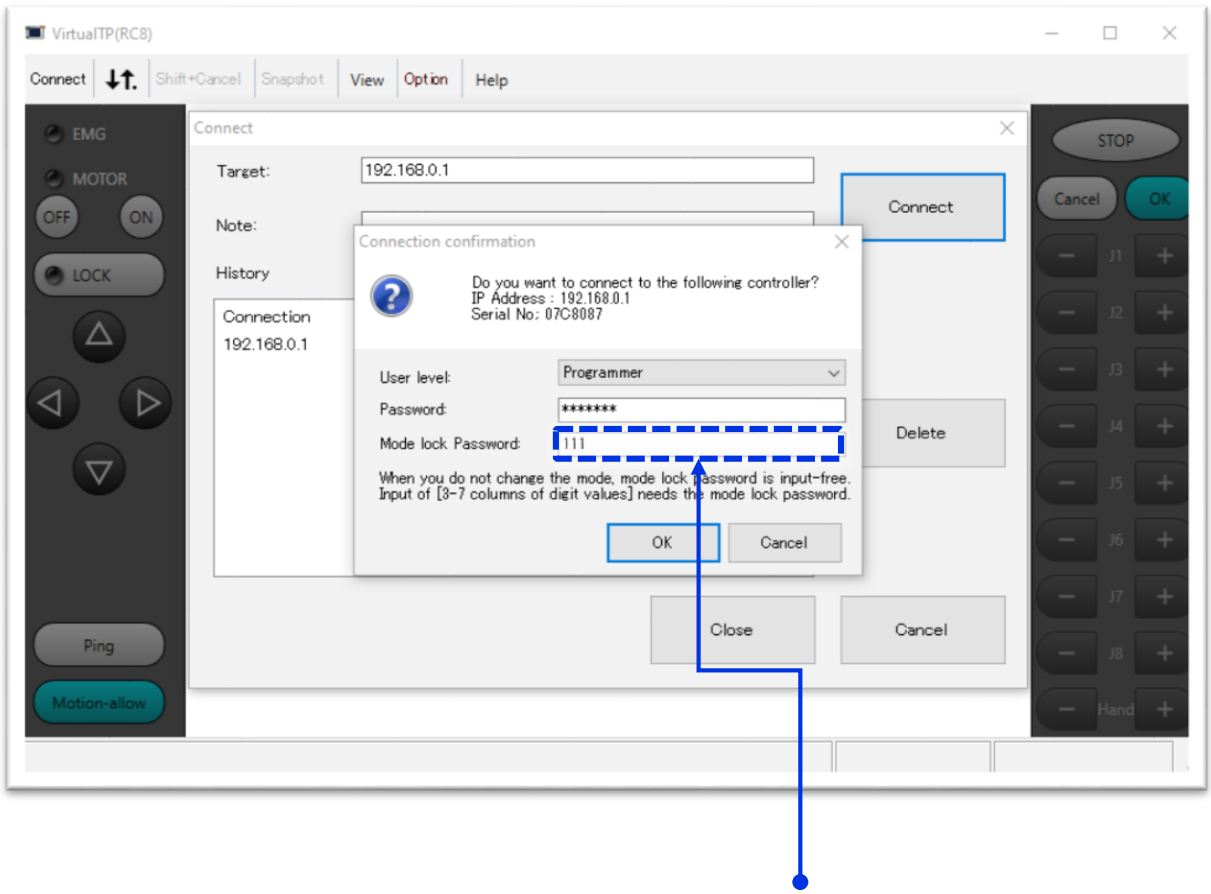
- Move the hand in the same orientation as when it is actually performing the pick operation.
- Move the arm to the lower four corners of the random pick area without changing the orientation of the hand.
- Move the arm to the upper four corners of the random pick area (the approach and depart height) without changing the orientation of the hand.
  Carefully consider the approach and depart height so that the robot arm does not interfere with other workpieces in the pick area when moving to the approach position.



View the status display screen for each axis while performing this work. Limits of motion range can be checked as the bars for each axis get closer to either end.
(In the figure below, J3 is approaching the limit on its range of motion.)



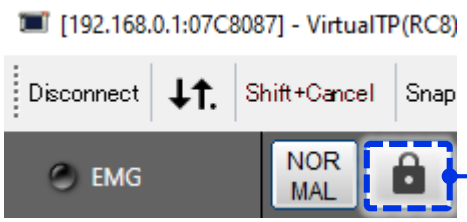
1 Start Virtual TP or Remote TP. At startup, set the mode lock password on the login screen.

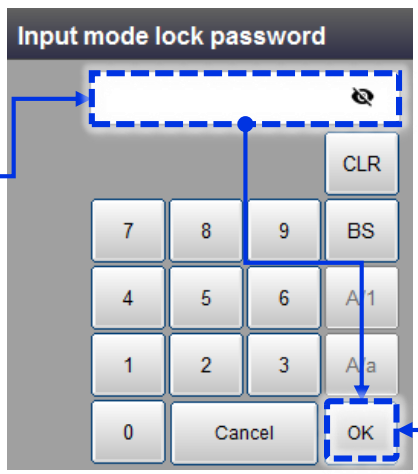


Enter the mode lock password.
Set a 3 to 7-digit number of your choice.

2 Switch to direct mode, and try moving the robot arm within the expected random pick area.

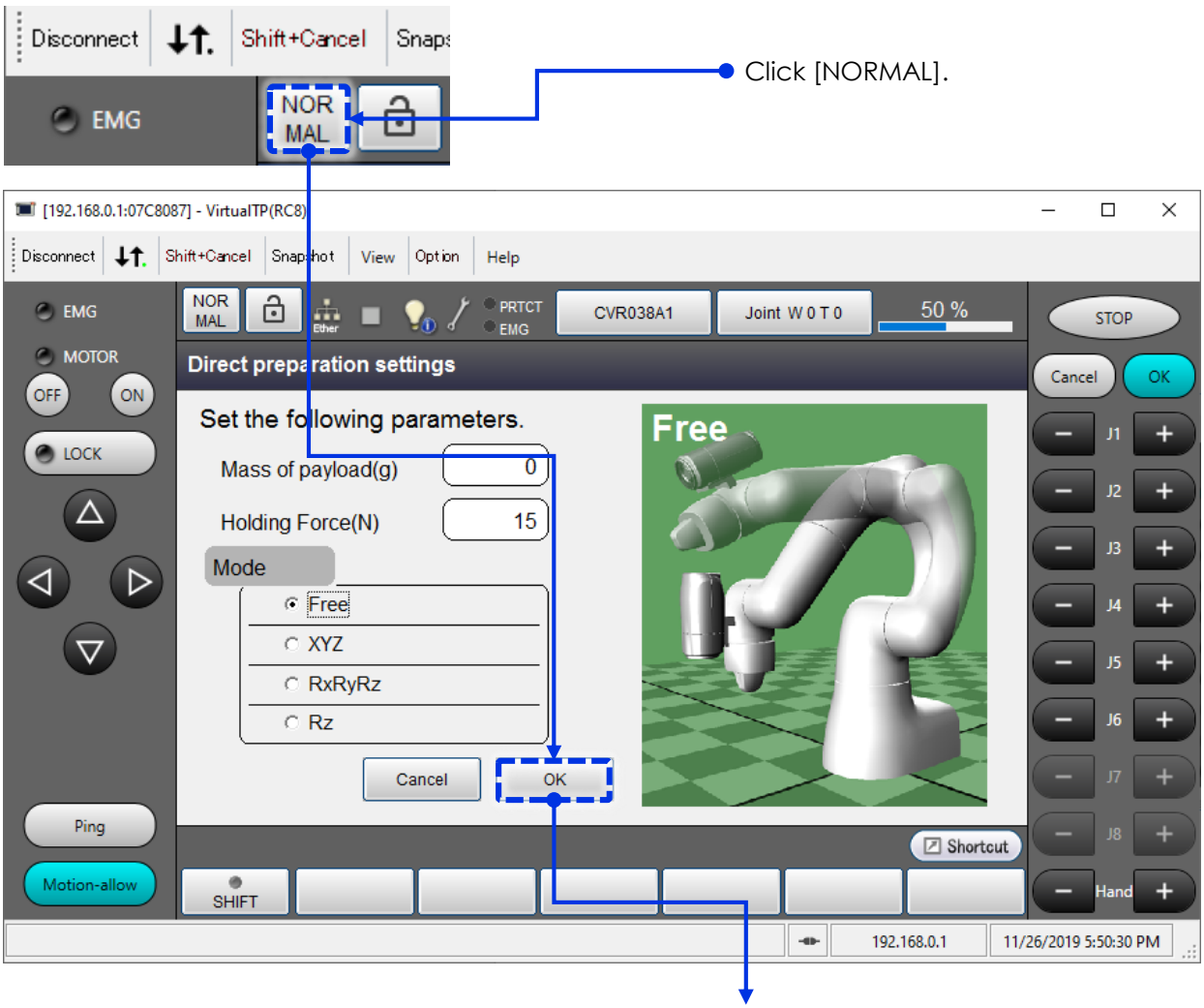
2-1. Click the mode lock icon on the top left side of the screen. Enter the mode lock password set in the previous step.





Enter the password, then click [OK].

2-2. Click [NORMAL], then click [OK] on the screen.
The mode switches to direct preparation mode.



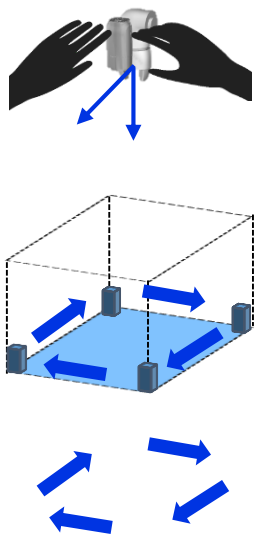
2-3. Press and hold the [FNC] button on COBOTTA's arm for at least 1.5 seconds, to switch to direct mode. The light on COBOTTA illuminates solid blue. Now, you can move the arm directly by hand.

LED flashes blue

Press and hold the [FNC] button for 1.5 seconds

LED illuminates solid blue

2-4. Check the random pick area.

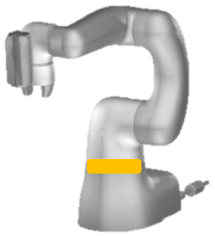


Move the hand in the same orientation as when it is actually performing the pick operation.

Move the arm to the lower four corners of the random pick area without changing the orientation of the hand, and confirm that no motion range errors occur.

Move the arm to the upper four corners of the random pick area without changing the orientation of the hand, and confirm that no motion range errors occur.

Note



If a motion range warning occurs, the LED illuminates solid yellow.

(2) Setting pick reference position P1 by TP

First, teach pick reference position P1. Since random pick coordinate correction is performed using the difference from P1, this setting greatly affects the accuracy of corrections. The important points to observe when teaching P1 are listed below.

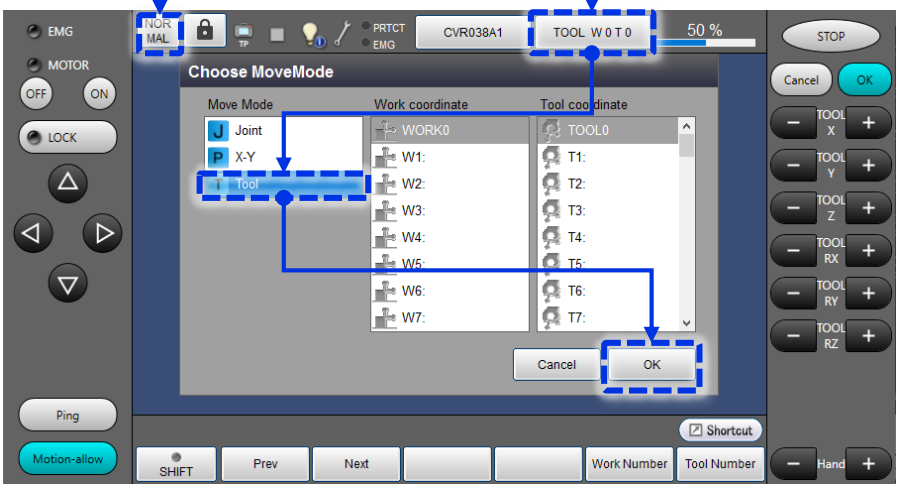
- **Point 1. Perform teaching for P1 with RX = 180°, Ry = 0°** (Note : J6 joint angle is recommended to set to 0° as a good practice but not mandatory for Vision Edition ver1.4.1.)
- **Point 2. Teach by actually grabbing the target workpiece.**

Virtual TP or Remote TP will be used and please refer page 7 and 8 for token setting.
Alternatively these settings can be done by Vision Edition functionality and jump to page 19.

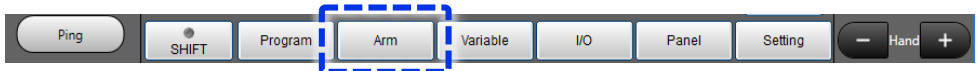
1 Start Virtual TP or Remote TP.
Place target workpiece in roughly the center of the pick area.

If in [DIRECT] mode, switch to [NORMAL] mode.

Change to display [TOOL W0T0] and click [OK].

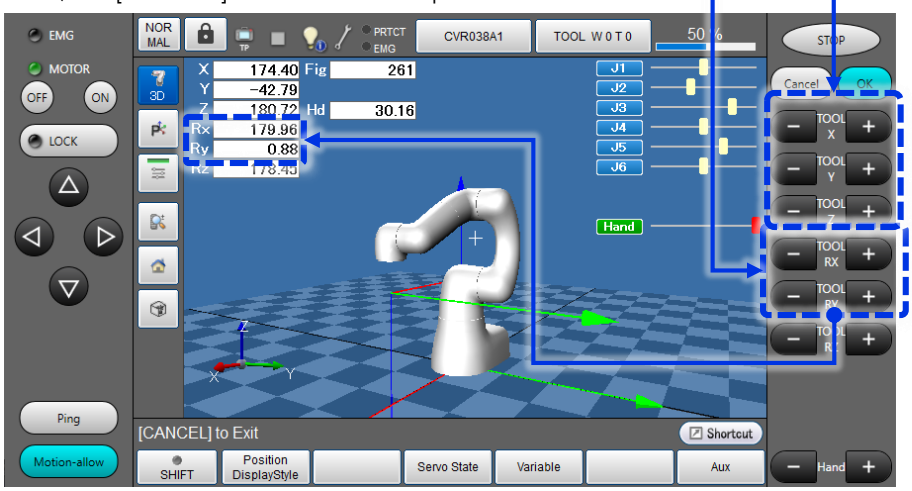


Click [Arm] to display robot arm and position parameters on the screen if not displayed.



First, set [TOOL RX] as close to 180° as possible.
Also, set [TOOL RY] as close to 0° as possible.

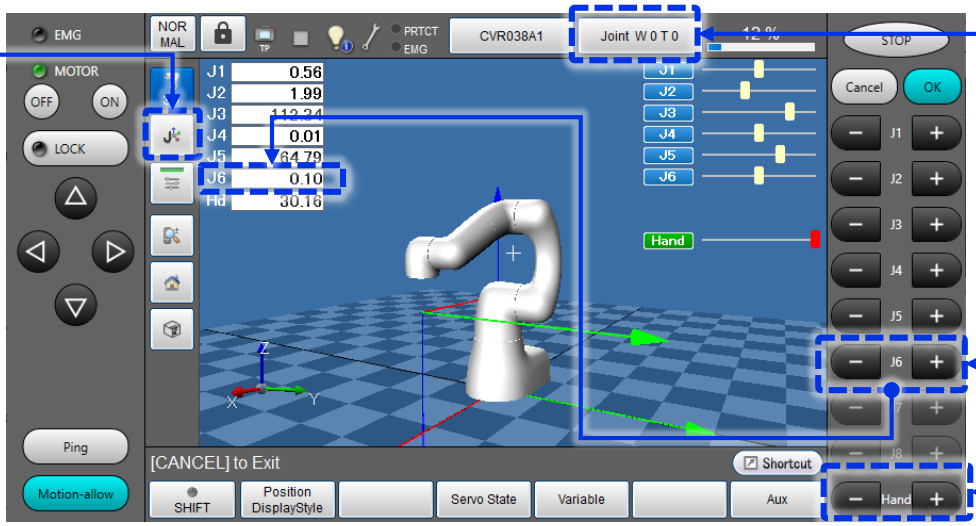
Next, adjust [TOOL X], [TOOL Y] and [TOOL Z] to move the robot arm roughly above the target workpiece.
Make sure that [TOOL RX], [TOOL RY] are not operated during this move and kept 180° and 0° respectively.



2 Set the J6 axis to 0°, and align the target workpiece to the hand.

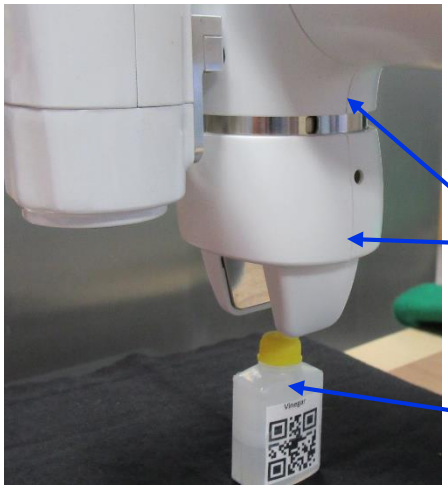
First ,change the teaching coordinate system from the previous tool coordinate system [TOOL] to the joint coordinate system [Joint].

Next, click this button to display joint angle values.
Then click [J6 +],[J6 -] to set J6 as close as possible to 0°.



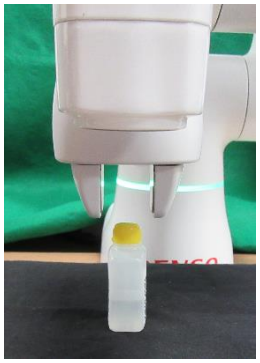
Adjust J6 to 0°.

Next, click the [Hand] button to open the hand wider than the size of the workpiece.



As J6 approaches 0°, these lines will align. When viewed from the front, the camera and hand will be in a straight line.

Position the target workpiece below the robot hand for it to be grabbed in the correct orientation.
(Place the workpiece in parallel to the robot hand = in parallel to the X axis of the tool coordinates system)



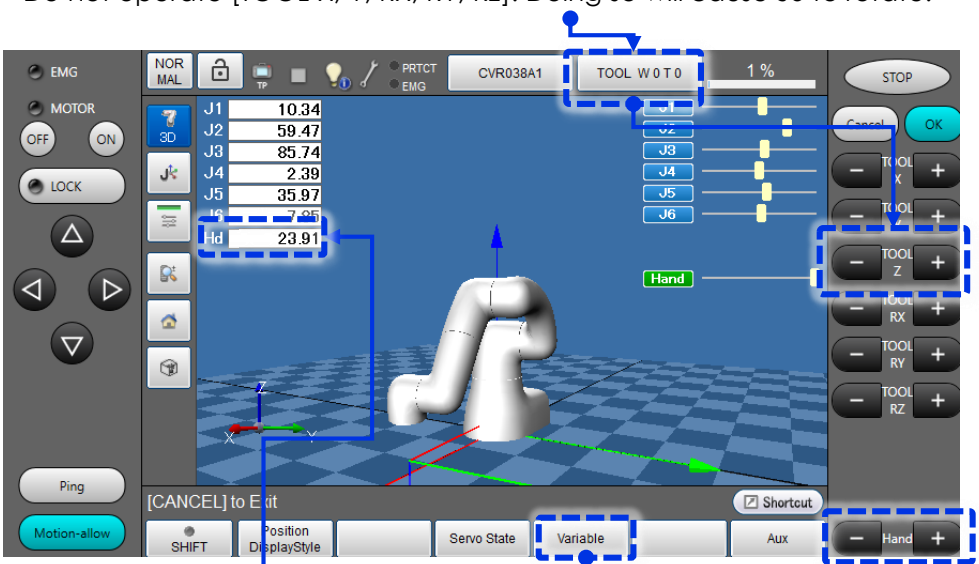
Correct

Incorrect

Place the workpiece at the position/angle where it should be grabbed when the robot hand is lowered.
(At this time, it is not necessary to precisely adjust the position/angle of the workpiece as its final position is defined after hand is closed.)

3 Lower the robot arm to grab the workpiece, and save the position as P1.

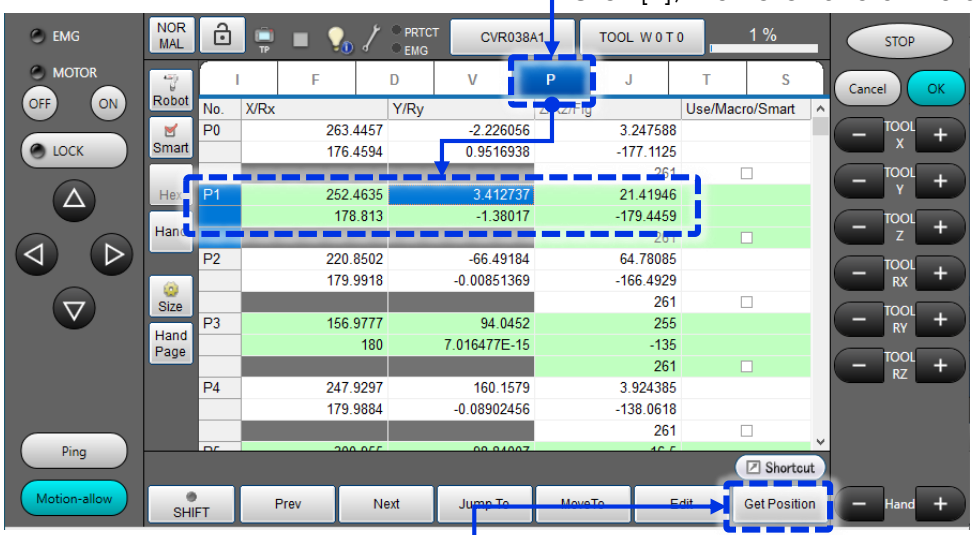
Click [Joint W0T0] to switch the movement mode from [Joint] to [Tool].
Operate [TOOL Z +] to lower the arm from the approach height to the pick height.
Adjust the position of the workpiece so that the center of the workpiece is aligned with the center of the hand.
Do not operate [TOOL X, Y, RX, RY, RZ]. Doing so will cause J6 to rotate.



Operate [Hand-] so that the hand holds the workpiece.
(The workpiece position may move slightly when the robot hand grabs it.)

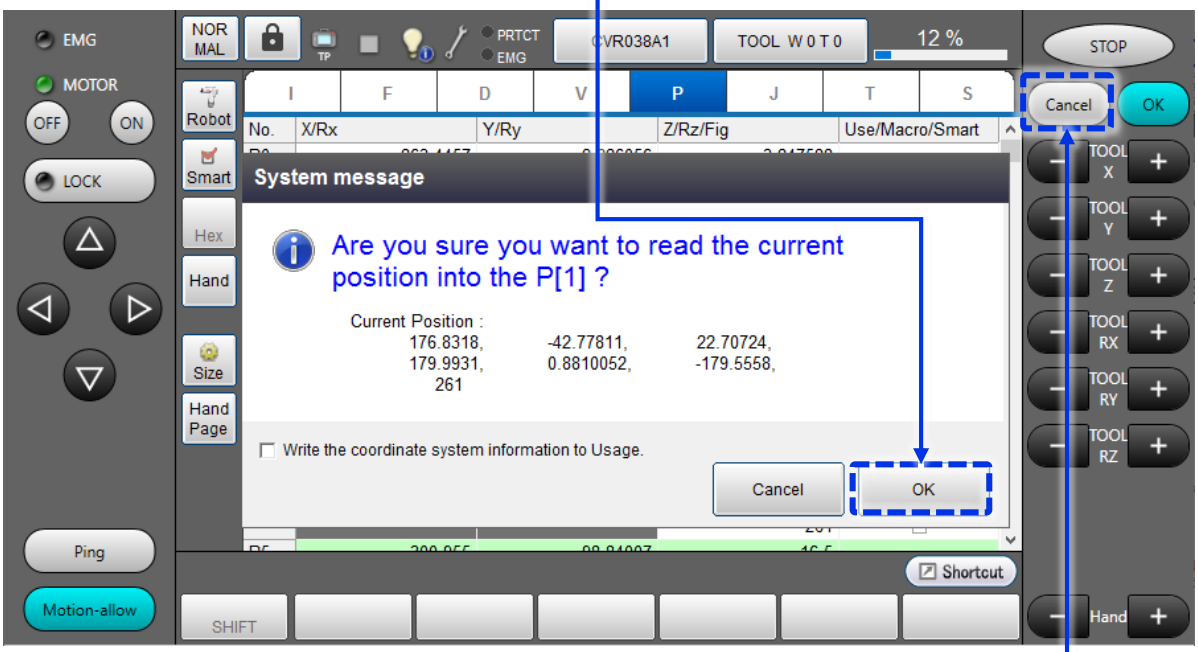
When the workpiece is held securely by the robot hand, make a note of the "Hd" value.
This value will be used later to set the robot hand grip.

After grabbing the workpiece with the robot hand, click [Variable] and save the current position as P1.
(This position will be the mechanical reference point for random pick.)
Click [P], then click one of the data cell to select P1.



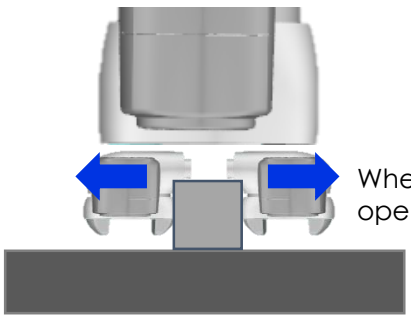
When you click [Get Position], a system message window is displayed.

Click [OK] to save the position in the robot's P1 memory.



Click [Cancel] button to return to the top screen.

Click [Hand+] a few times to release the workpiece. Make sure to release the workpiece slowly so that it does not move.



When you click [Hand+], the hand opens in the direction of the arrows.

Note

The position of the workpiece will become the pick reference position.
In the following steps, take care not to move it until you have captured a master image from overview position.

4 Return the executable token to [Ethernet] (refer page 7 and 8) so that you can use Vision Edition to perform operations in the following steps.

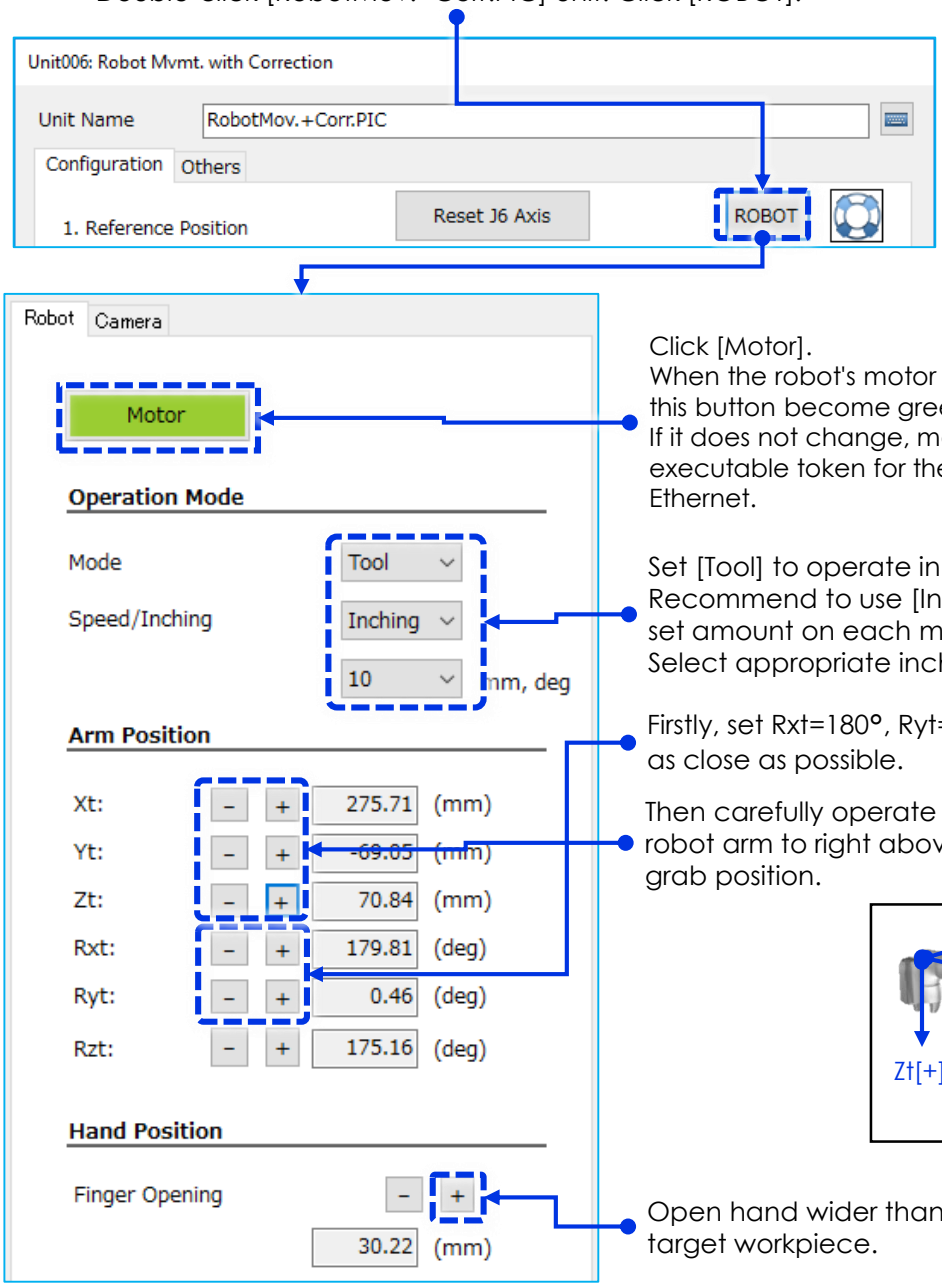
(2-alternative) Setting pick reference position P1 by Vision Edition

In order to set P1 by Vision Edition robot control functionality, please set token to [Ethernet]. (Please refer page 7 and 8.)

1 Carry out the procedure from P22 to P25 (Create a New Job, register the camera and the robot, create a flowchart)
Place target workpiece in roughly the center of the pick area.

2 Using [RobotMov.+Corr.PIC] unit Robot Control window, set Rxt=180°, Ryt=0° as close as possible.
Then move robot arm to right above the grab position by operating Xt/Yt/Zt.

Double-click [RobotMov.+Corr.PIC] unit. Click [ROBOT].

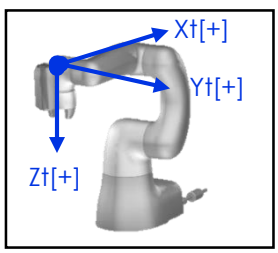


Click [Motor].
When the robot's motor can be controlled, this button become green as shown.
If it does not change, make sure the executable token for the robot is set to Ethernet.

Set [Tool] to operate in Tool coordinates.
Recommend to use [Inching] to move set amount on each mouse click.
Select appropriate inching amount.

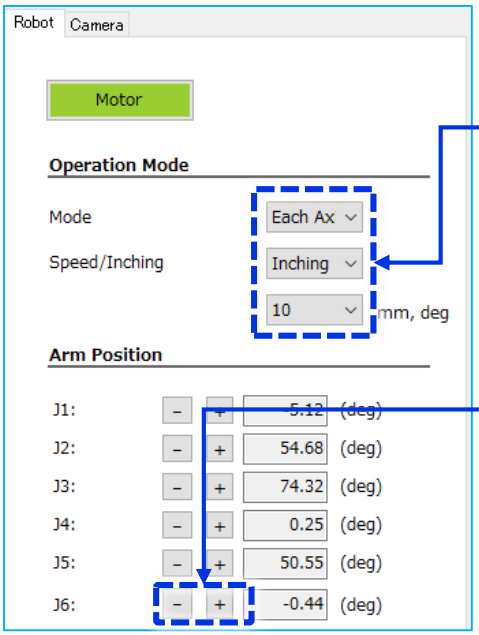
Firstly, set Rxt=180°, Ryt=0° as close as possible.

Then carefully operate Xt/Yt/Zt to move robot arm to right above the workpiece grab position.



Open hand wider than the target workpiece.

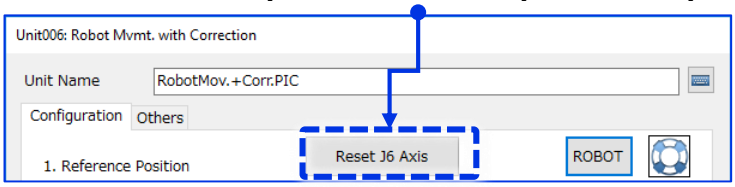
4 Set J6 joint angle to 0°. (Either in the Robot Control window or [Robot Mvmt. With Correction] unit.)



Set [Each Axis] to operate in J6 axis.
Recommend to set [Inching] and move set amount by each mouse click.
Select appropriate inching amount.

Then operate J6[+] or J6[-] to set to 0°.

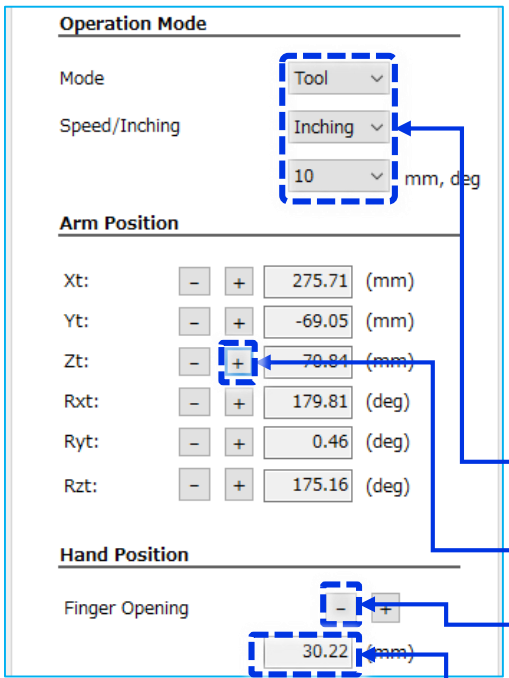
Alternatively return to [Robot Mvmt. With Correction] window and click [Reset J6 Axis].



Note

J6 joint angle is recommended to set to 0° as a good practice but not mandatory for Vision Edition ver1.4.1.
In order to avoid J6 joint angle to go over the movement limitation, sometime model angle may need to set from -170° to +170° and setting J6 joint angle to 0° will help.
(It depends on the workpiece shape which may cause J6 joint angle limitation issue.)

5 Lower the robot arm and close the hand to grab the workpiece. Note the finger opening value.



Place the workpiece to the position/angle so that lowered robot hand can correctly hold.

Correct

Incorrect

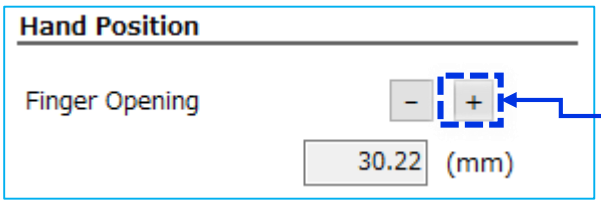
Set [Tool] to operate in Tool coordinates.
Use [Speed] when operate the hand position.

Carefully Operate Zt[+] to lower the robot arm to grab position.

Set [Speed] and carefully operate [-] to close the hand to hold the workpiece.

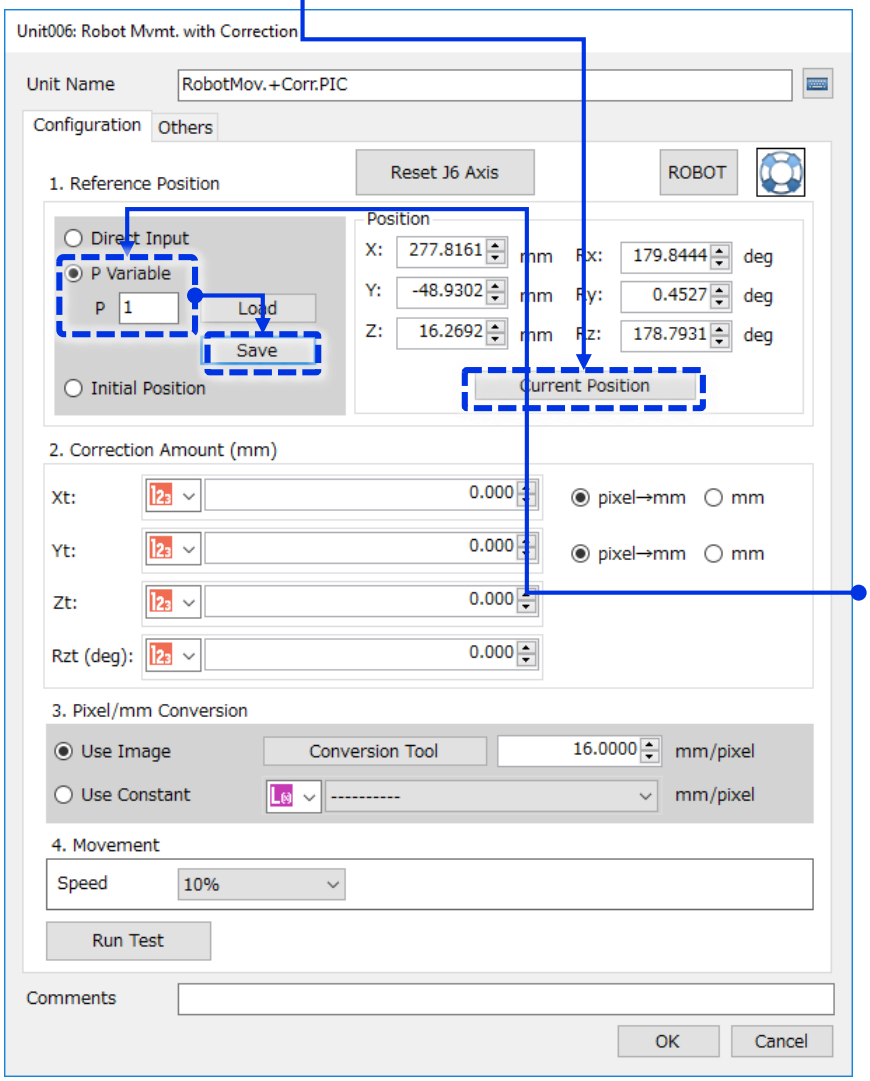
Take note of the finger opening amount when securely hold the workpiece.

6 Open the hand again.
Read current arm position and save to P1 memory.



Carefully open the hand but making sure that workpiece position does not move. Then click [Close] to close Robot Control window.

Click [Current Position] to obtain the current robot coordinates. (The current coordinates are displayed.)
Overwrite warning window appears and click [OK] to close.



Then tick [P Variable], enter "1" and click [Save].

Pick reference position is saved in the robot's P1 memory.

Click [OK] to close.

Note

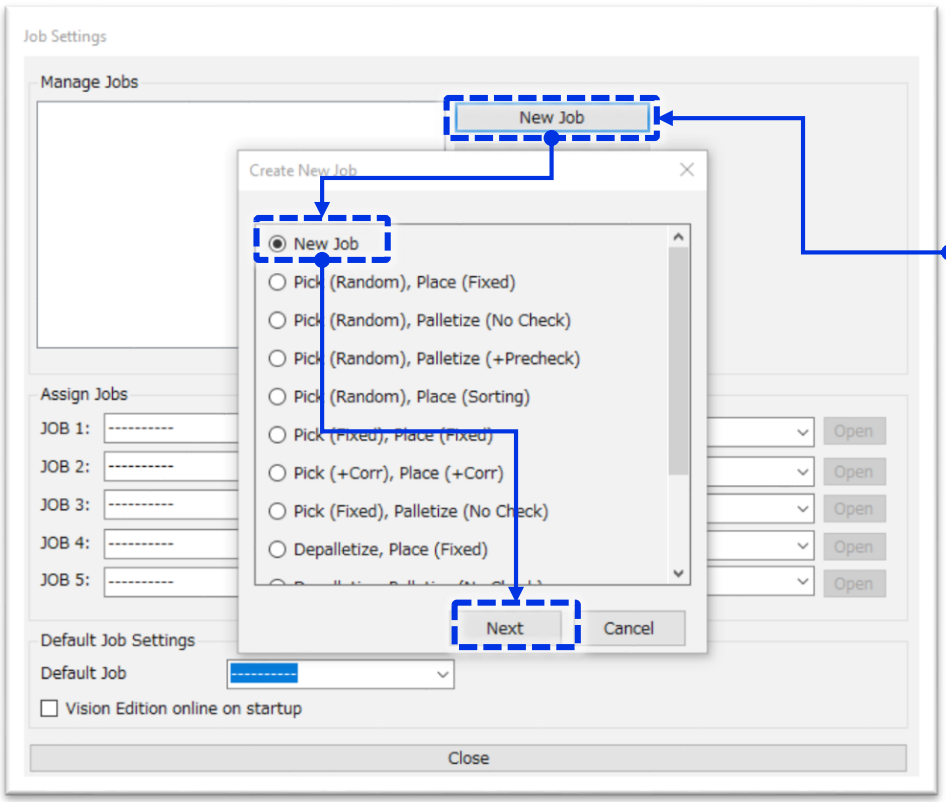
The position of the workpiece will become the pick reference position.
In the following steps, take care not to move the workpiece until you have captured a master image from overview position.

7 Move onto P26 step4.

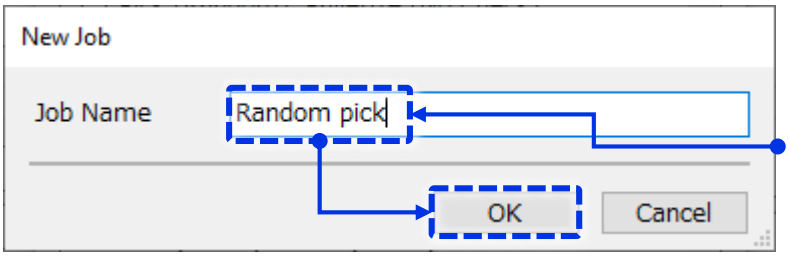
(3) Setting image capture position P0

Use Vision Edition to move the robot arm to image capture position, and set this position as P0. If you use the robot operation panel in Vision Edition, you can move the robot arm while viewing the camera image of the target workpiece.

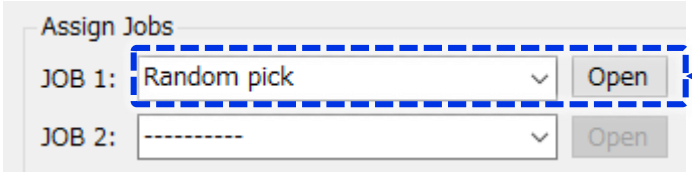
1 Make sure to switch the token to Ethernet and disconnect the Denso Wave app (Virtual TP/Remote TP) first, then use Vision Edition to create a new job.



Click [New Job], select [New Job], and then click [Next].

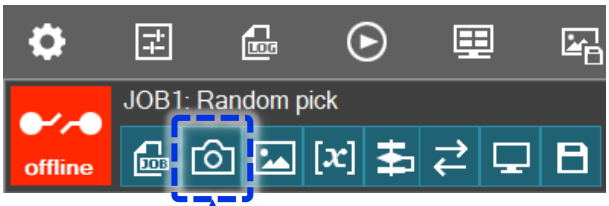


Rename the job (user-defined) and click [OK].



Select the job created in the previous step and open.

2 Register the camera and robot to the job.

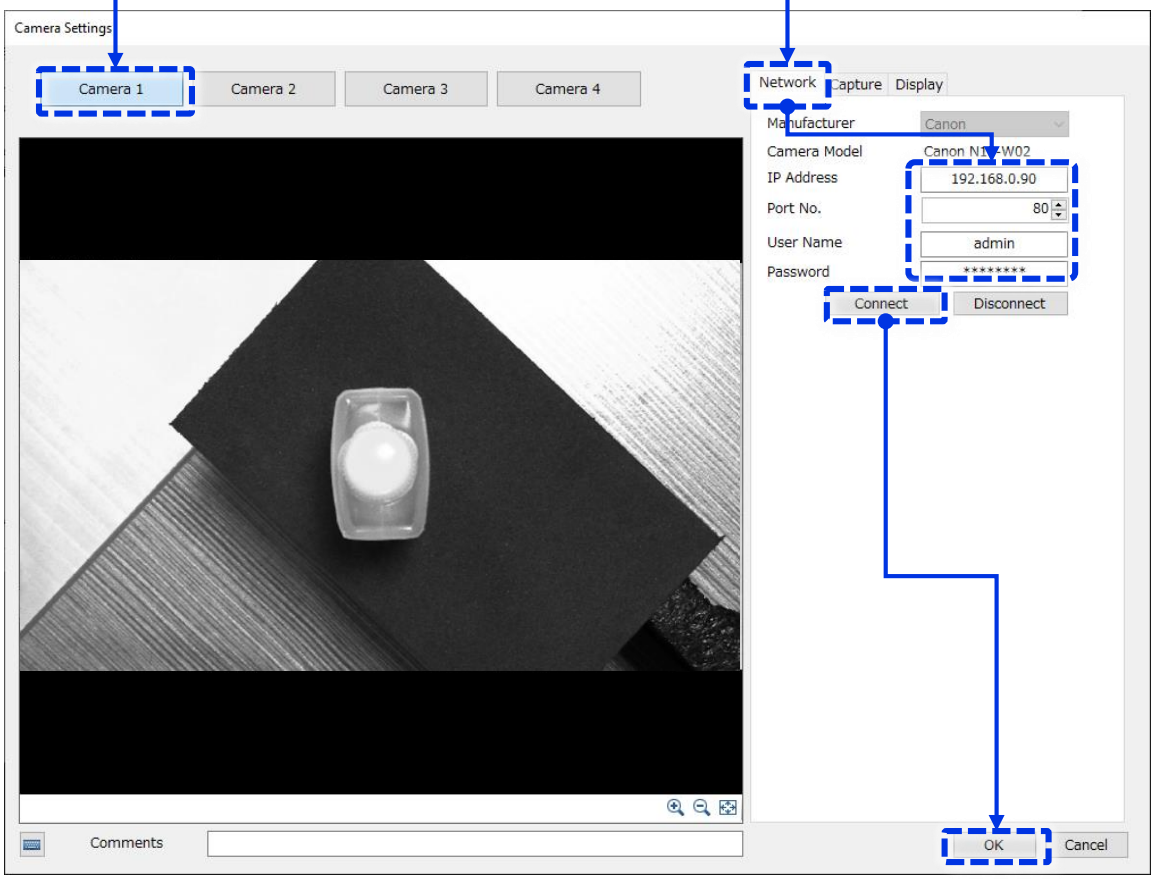


Click [Camera Settings].

Select [Camera 1].

Select the [Network] tab, and enter the required information and click [Connect].

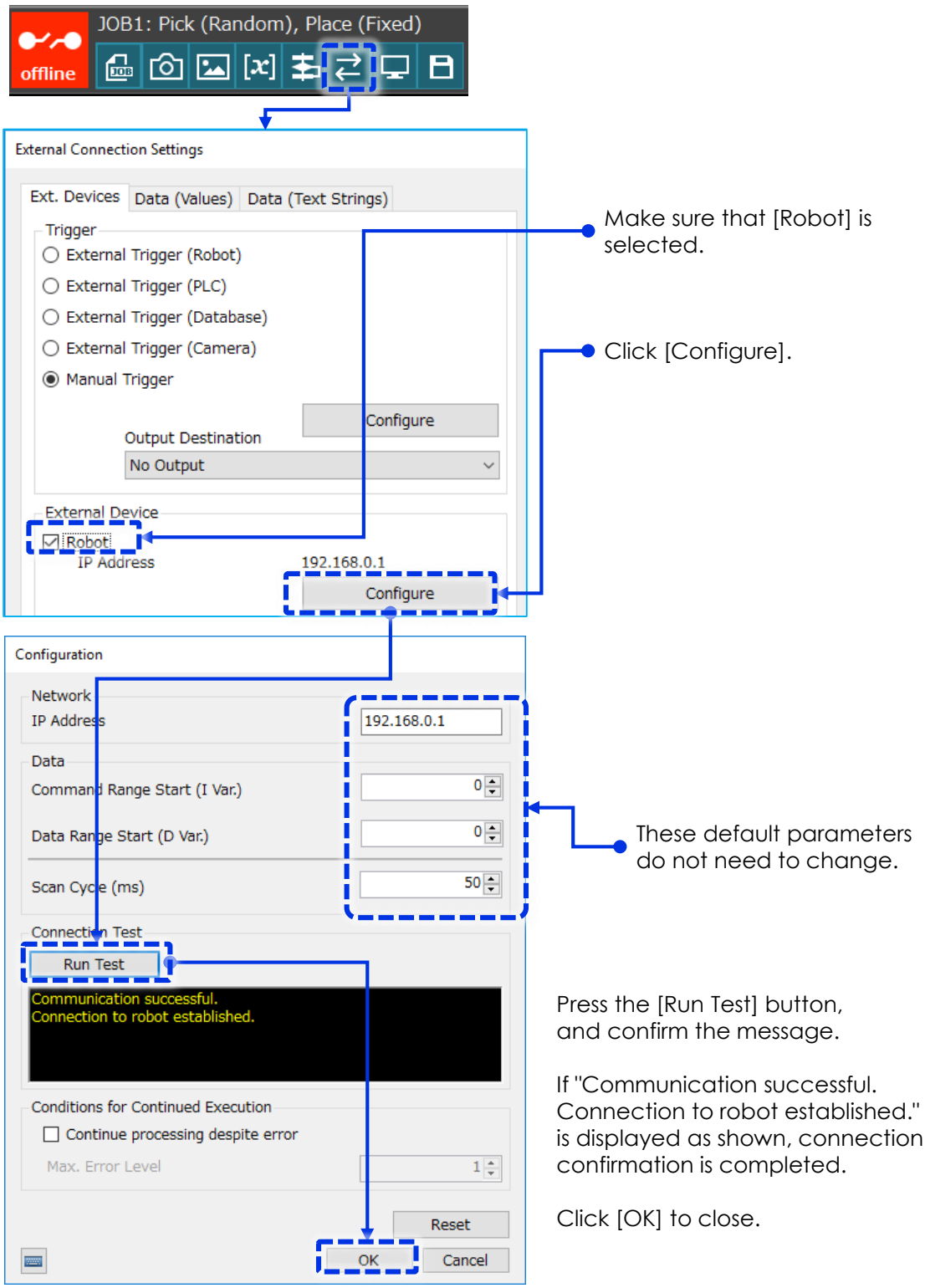
Default settings for N10-W02 camera is below.
- **IP Address: 192.168.0.90**
- **Port No.: 80**
- **User Name: admin**
- **Password: password**



Click [OK] to complete camera registration.

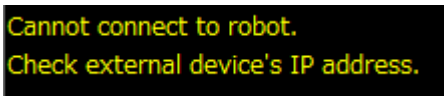
* No need to be able to view the workpiece at this stage since detailed image capture conditions will be configured in a separate procedure.

Click external connection icon button to connect the robot.

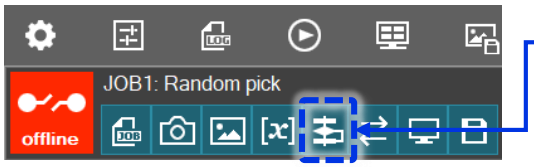


Note

If an error similar to the one below occurs when you press [Run Test], (1) check if LAN cables are connected securely, (2) check the IP addresses for the robot and the image processing controller.



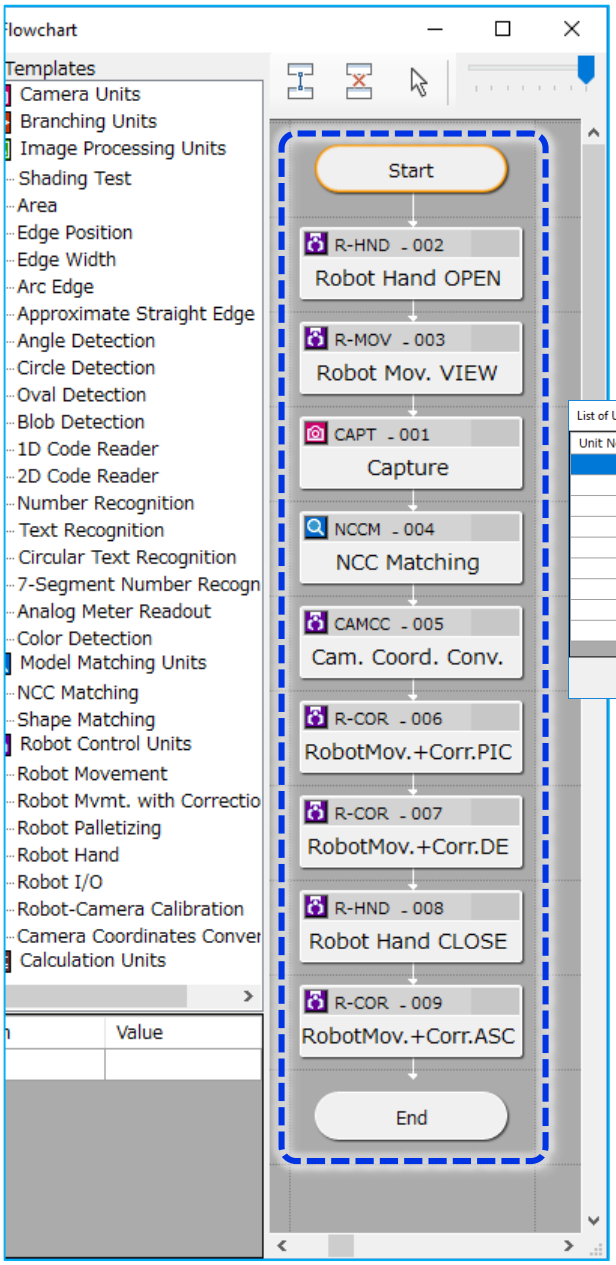
3 Create a flowchart.



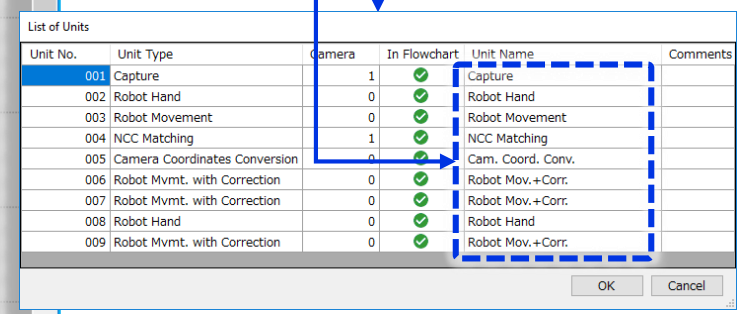
Click [Edit Flowchart].

A new flowchart contains only image capture unit.
Drag & drop the remaining operation units onto the flowchart and connect them as shown below.
Double-click each operation unit to change its name for the ease of identification.
(Alternatively click [Unit List] to open [List of Units] table and double click the cell to rename.)

Although renaming is not mandatory, it makes programming and maintenance easier.



Click [Unit List] and double click the cell to rename.

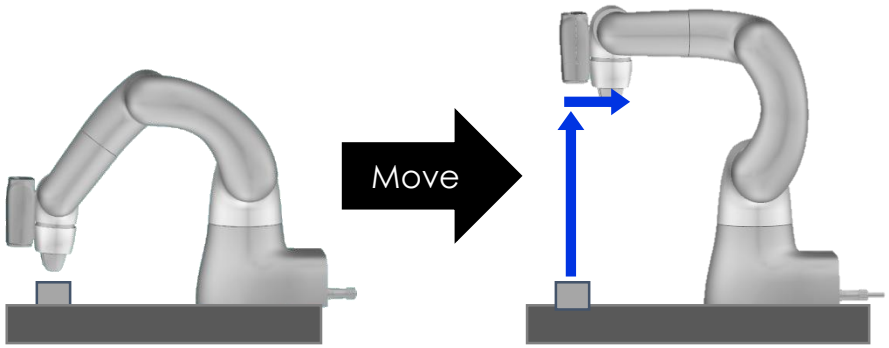


Note

The number of each operation unit is automatically assigned in the order of drag & drop to the chart and cannot be changed.

ID numbers are for the identification purposes only and no bearing on the actual programming.

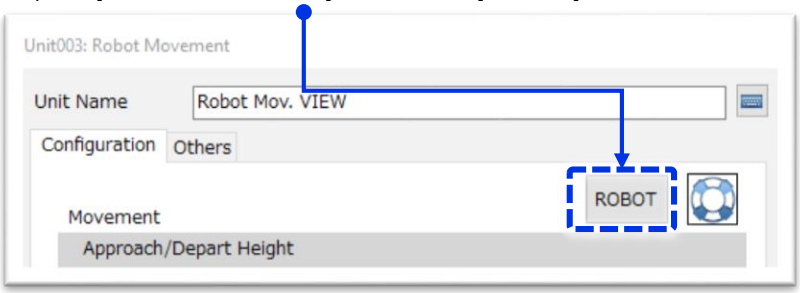
4 Raise the robot arm to a position where an image of the target workpiece as a mechanical reference can be captured by the camera.
Adjust Xt, Yt and Zt so that the entire random pick range fits within the camera view.
(Just adjust Zt[-] and Xt[+] should be suffice to bring pick area into camera view.)

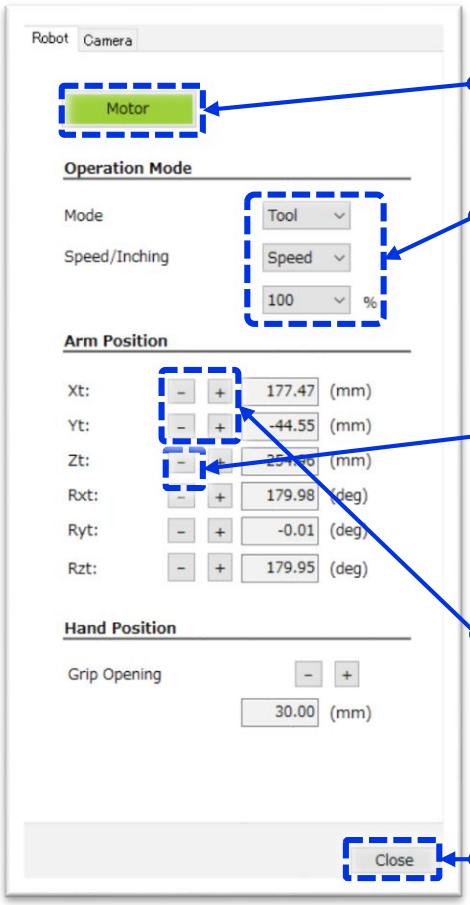


Current robot status after completing step (2)

Robot status after moving to the camera image capture position

Open [Robot Mov. VIEW], and click [ROBOT].

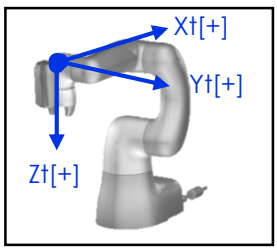




Click [Motor].
When the robot's motor can be controlled, this button become green as shown. If it does not change, make sure the executable token for the robot is set to Ethernet.

Set selections as shown.
Alternatively, use [Inching] with appropriate movement amount for each mouse click.

First, raise the robot arm by clicking Zt[-] to clear from the workpiece.
Click it only a little at a time.
(Do not click and hold.)



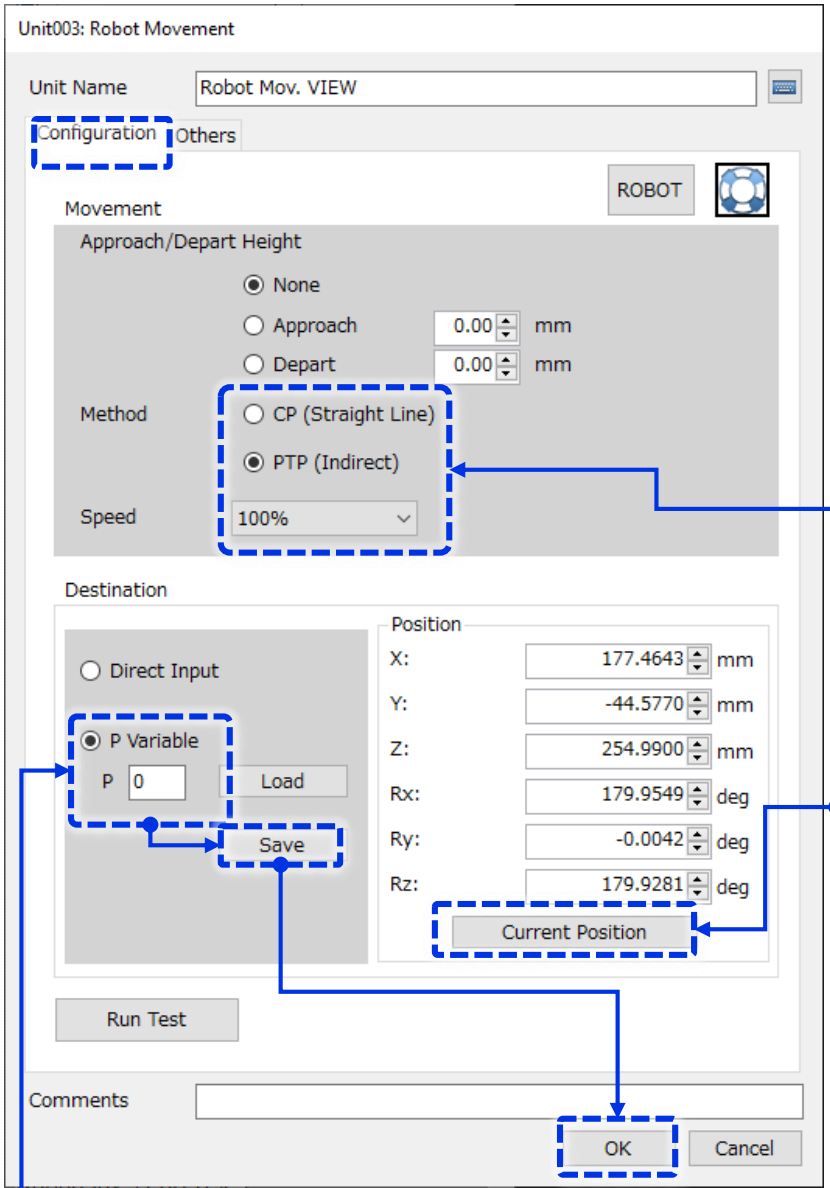
Next, move the robot arm backward so that the camera moves above the target workpiece.
Make adjustments using Xt button.
(And if necessary, Yt button.)

After adjustments are completed, click [Close].

Memo

If the robot arm does not move as fast as you expected when clicking Zt[-] after setting the speed to 100% in Vision Edition as described on the previous page, increase the external speed in TP.
The speed for COBOTTA in Vision Edition will be "the external speed in TP" x "the speed set in Vision Edition".
Alternatively set [Inching] instead of [Speed] and set appropriate movement amount for each mouse click.

5 Register the robot position as image capture position P0.



Configure as shown.

Click [Current Position] to obtain the current robot coordinates.
(The current coordinates are displayed.)

Then tick [P Variable], enter "0" and click [Save].
Image capture position is saved in the robot's P0 memory.

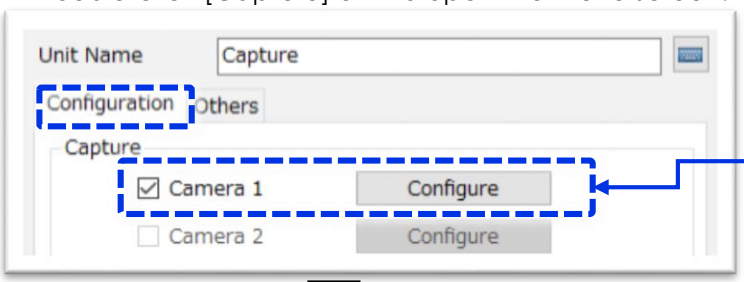
Click [OK].

(4) Creating the master image for pattern matching

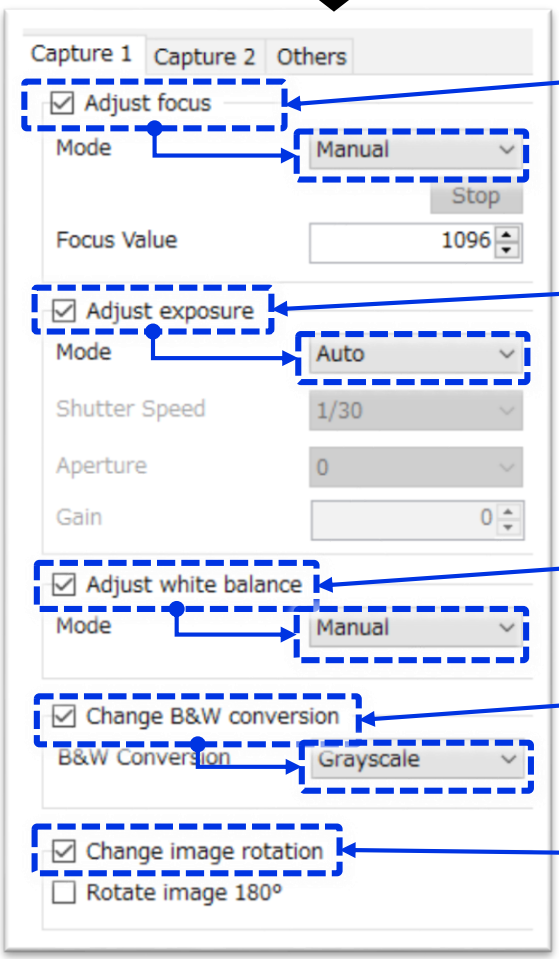
Before creating a model for pattern matching, provide the best lighting conditions possible then capture and register the master image.

1 Set the capture conditions.

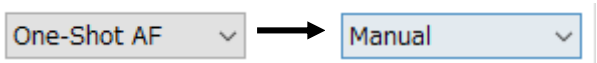
Double-click [Capture] unit to open the menu screen.



Select Camera 1 and click [Configure].



Select [Adjust focus] and set the mode to [One-Shot AF].
After auto focus adjustment is completed, it will automatically return to [Manual].



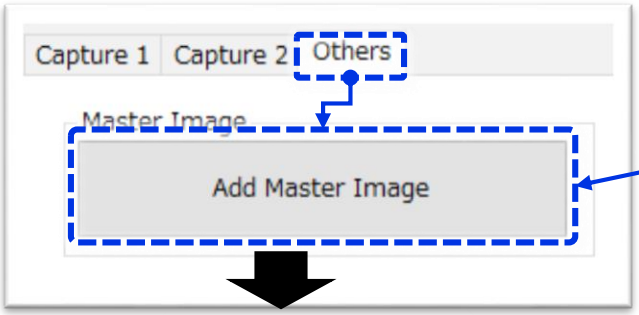
Select [Adjust exposure] and select [Auto].
If the target workpiece is too dark or white out and not able to view the detail for NCC pattern matching, change to [Manual] and adjust to obtain detailed image.
For Shape pattern matching, clean outline contrast of workpiece is important.

Select [Adjust white balance] and select [Manual].

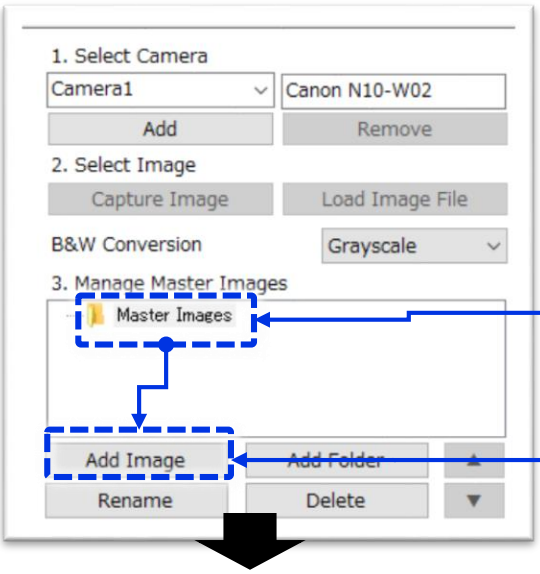
Select [Change B&W conversion] and select [Grayscale].

Select [Change image rotation].
Selecting this option fixes the normal capture orientation.

2 Register the master image of the target workpiece.

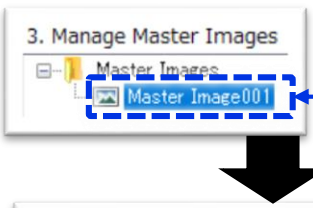


Select the [Others] tab then click [Add Master Image].

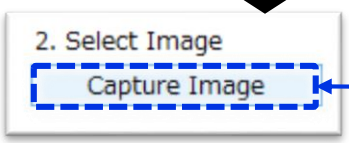


Select the Master Images folder.

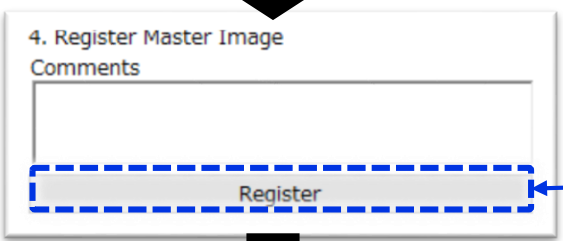
Select [Add Image].



Select the added image file.



Click [Capture Image].



Click [Register] to store the captured image.

Click [OK] to close the master image setting screen.
Then click [OK] two more times to close the capture settings screen.

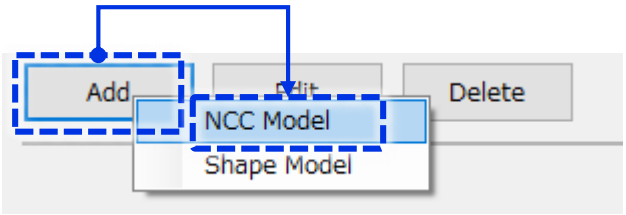
(5) Creating a pattern matching model (NCC)

Create an NCC pattern matching model from the master image.
With consideration for the shape of the workpiece for picking, carefully determine the angle range of the model to be created.
(Because there is a -170° to +170° limit to the range of motion for the COBOTTA J6 rotation angle)

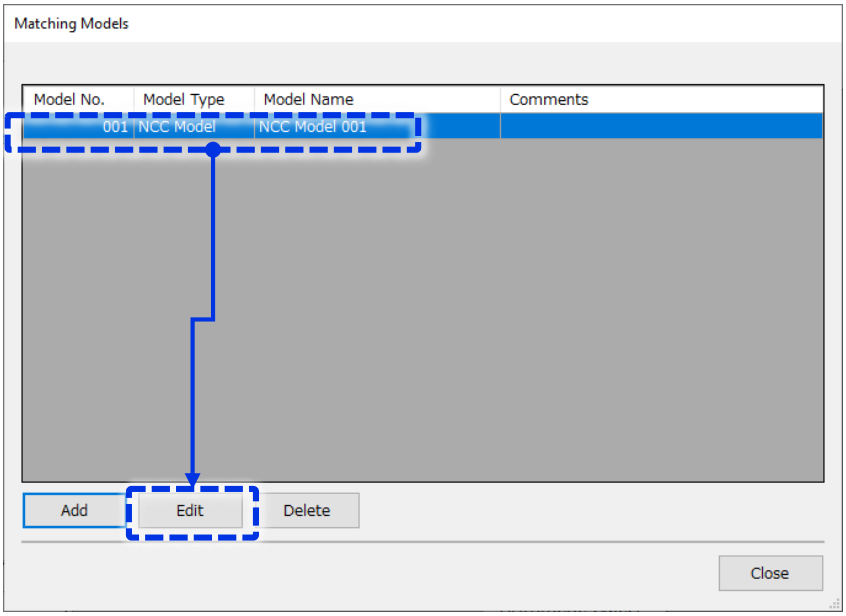
1 Click [Flowchart].

2 Click [Conf. Models].

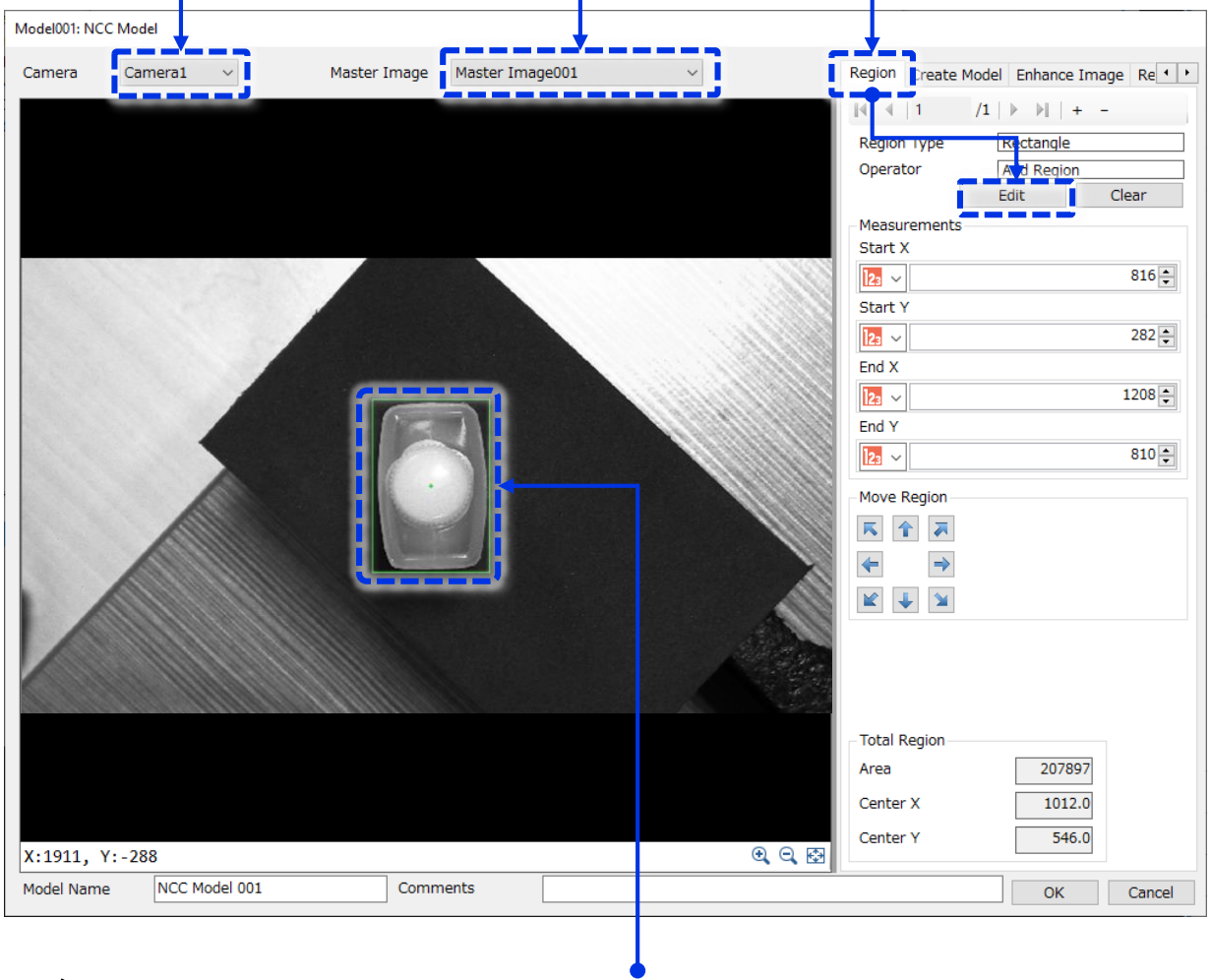
3 Click [Add], then select [NCC Model].



4 Highlight the NCC model created, then click [Edit] at the bottom of the screen.

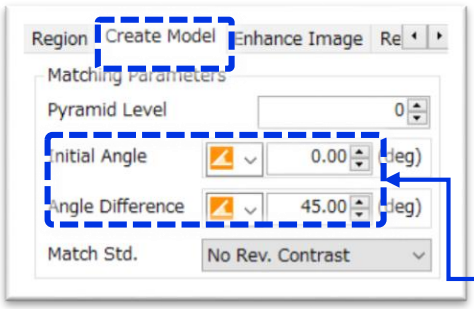


5 Select [Camera1] and [Master Image001]. Then select [Region] tab and click [Edit].



6 Mouse left-click to draw the region and right-click to confirm.
Set the region to cover the outline shape of the workpiece.
(If other region shape is required, delete Region Type by clicking [-] and add new Region Type.)
Green cross marking indicates the center of gravity of the region and this will be the target pick coordinates for the detected workpiece.

7 Click [Create Model] tab and set the angle range of the model.



If the workpiece is symmetrical both left-right and up-down, registering 180° as shown below is sufficient.

[Initial Angle]: -90.00
[Angle Difference]: 180.00

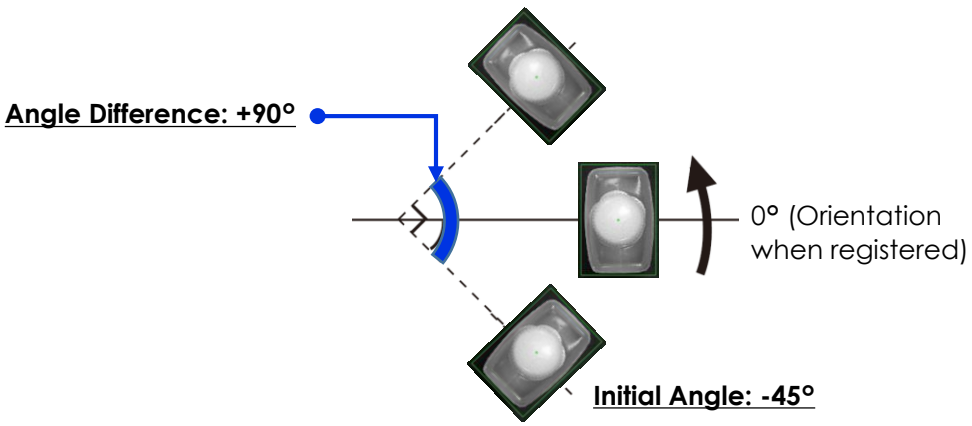
If the workpiece is not symmetrical, register 340° as shown below.

[Initial Angle]: -170.00
[Angle Difference]: 340.00

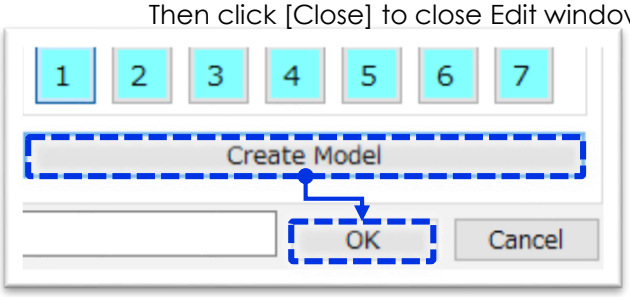
This is because if asymmetrical shape workpiece with 360-degree model is created, depends on the angle of the detected workpiece, COBOTTA J6 joint angle may exceed the limitation (from -170° to +170°) and motion limitation error could occur.

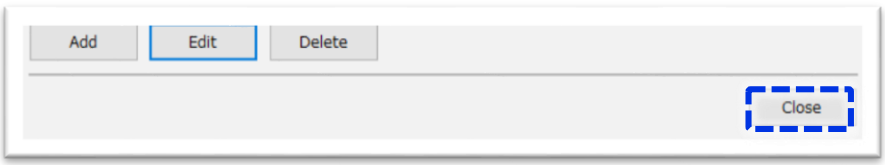
Note

In the following example, the created model detects a bottle rotated from -45° to +45°.
A bottle rotating at +60°, for example, would not be detected.



8 Click [Create Model]. When the model creation process is complete, click [OK] to close the message screen.
Then click [Close] to close Edit window and [Close] to close the model window.



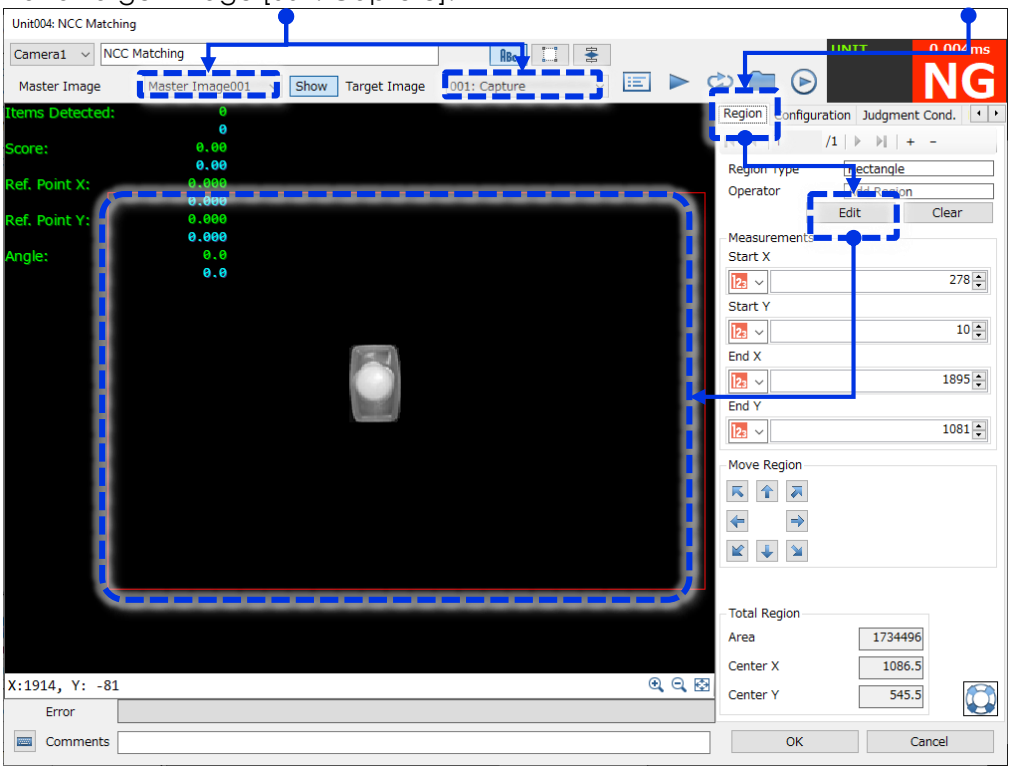


(6) Configuring the pattern matching unit

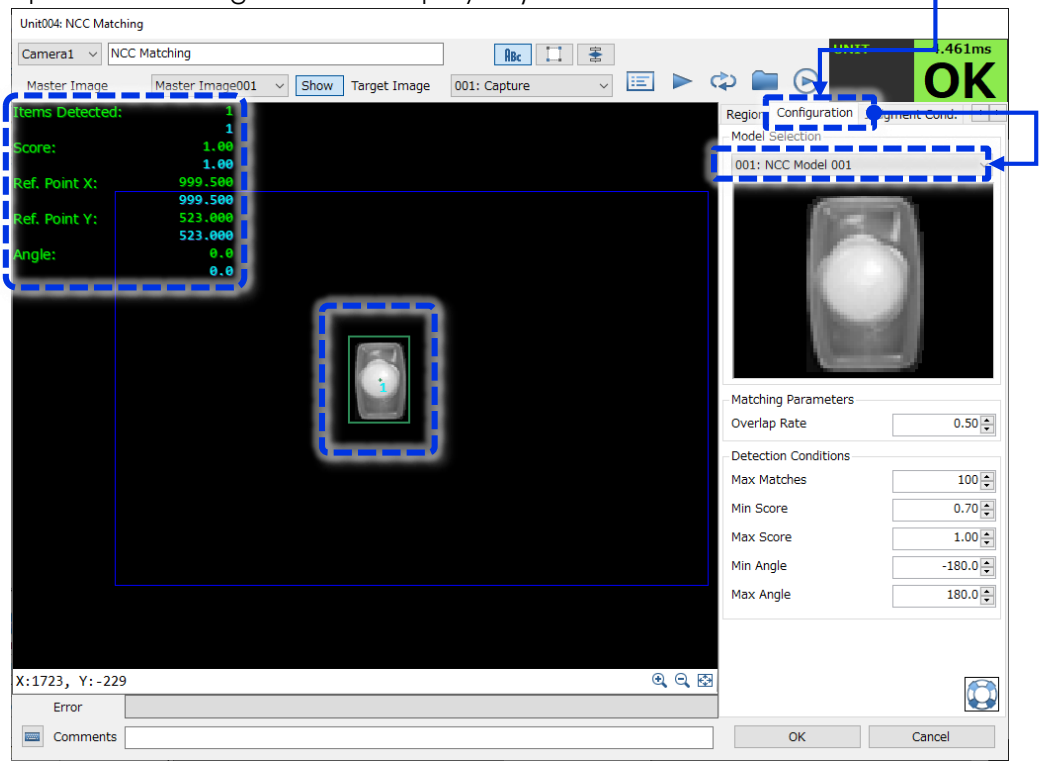
Use the master image to configure the NCC matching unit, and try a variety of different workpiece positions and angles in the pick area.

Double-click [NCC: NCC Matching].
Select Master Image [Master Image001] and Target Image [001: Capture].

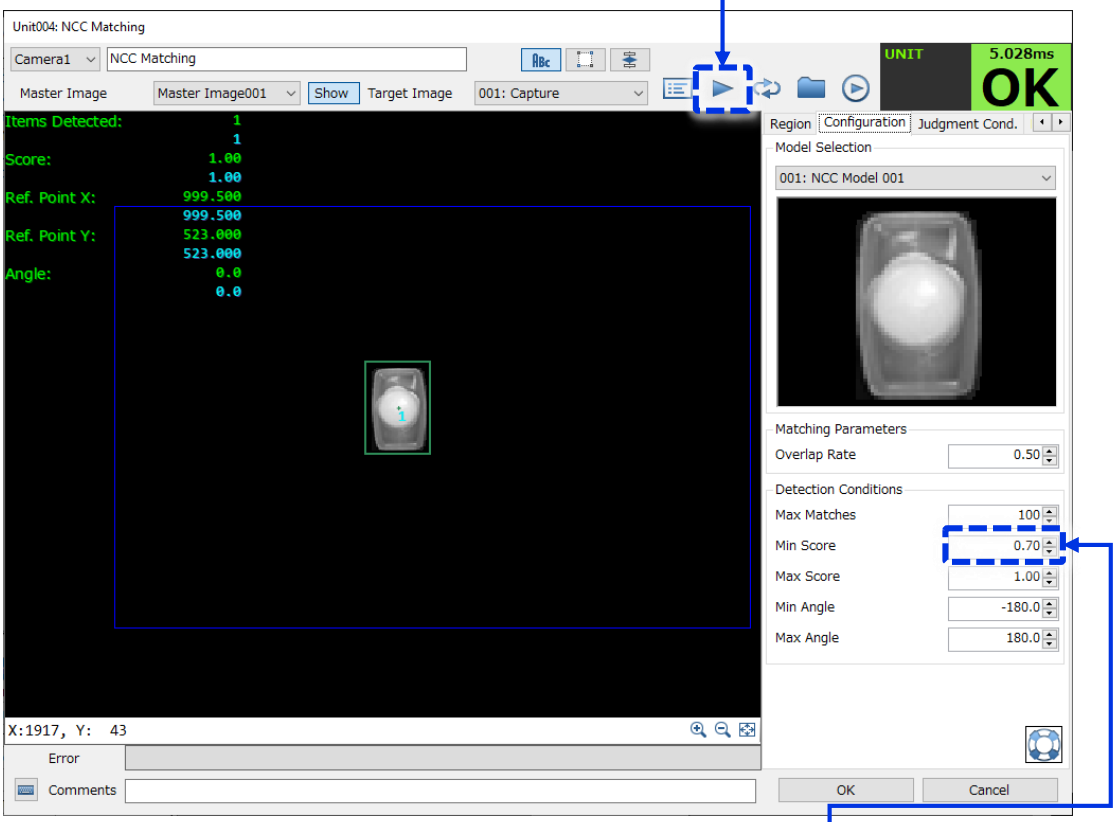
Click [Edit] on the [Region] tab, and set the random pick area which should be the same as the area checked at P14.

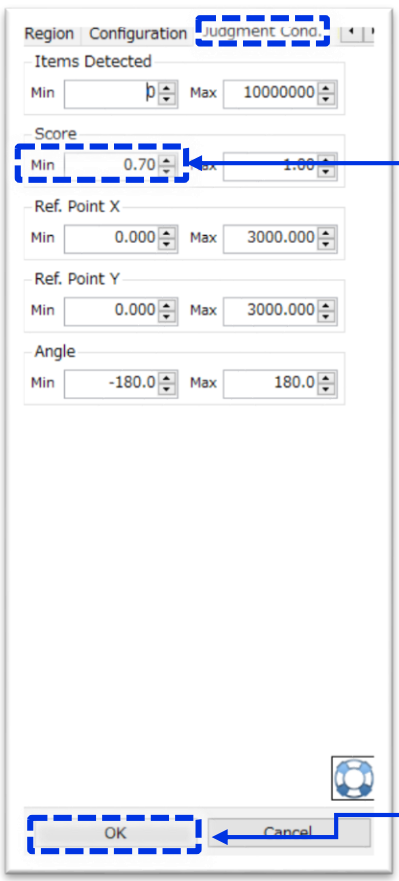


On the [Configuration] tab, select Model [NCC Model 001].
(A green line is displayed around the workpiece. The detected position and angle are also displayed.)



Change the position and angle of the workpiece in the pick region, then click [Trigger] to run detection tests.





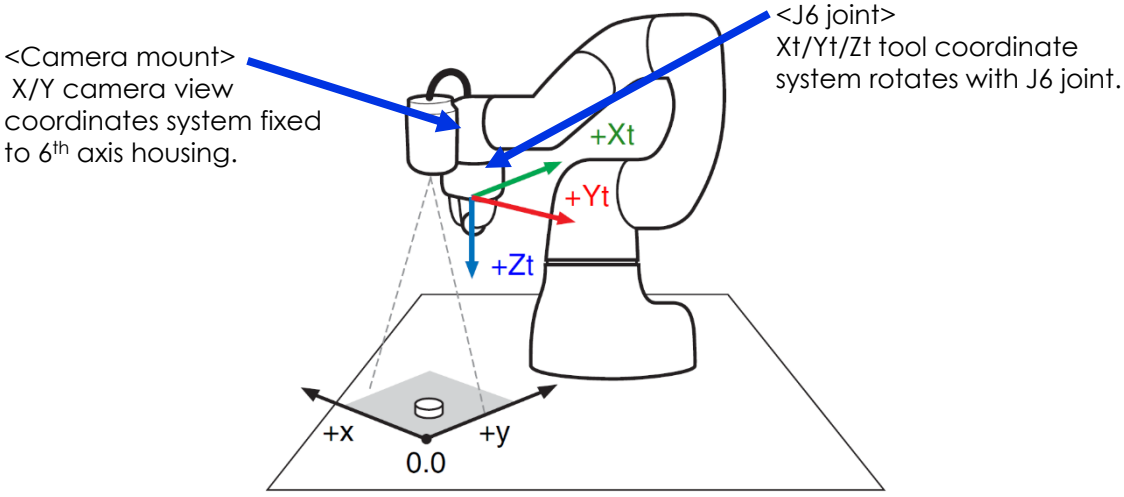
Adjust the minimum score (around 0.70) on the [Configuration] tab, and the minimum score (around 0.70) on the [Judgment Cond.] tab, to determine whether detected workpiece's position and angle is accurate.

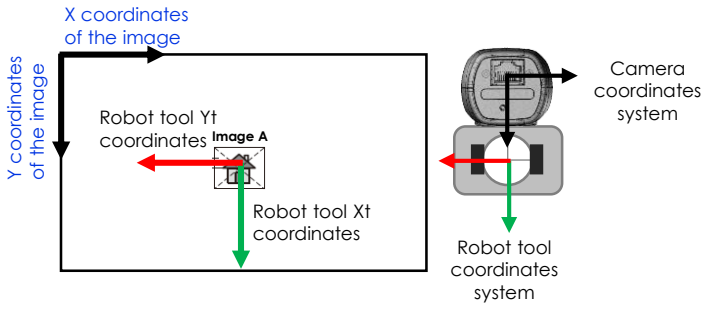
When the settings are completed, click [OK] to close.

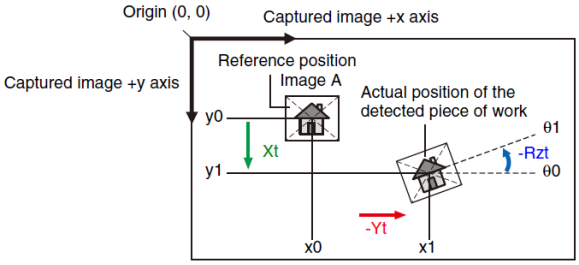
(7) Converting the image processing unit coordinate system and the robot coordinate system

The positional displacement of a workpiece captured by the camera must be converted into the robot coordinates system. The relationship between the camera coordinates system and the tool coordinates system is shown below.

The camera is fixed to 6th axis housing but the tool coordinates system is based on the tool flange and it rotates according to the J6 joint angle.
Below calculation assumes between camera view coordinates system looking from the image capture position and tool coordinates system at the pick reference position, +x axis is parallel to –Yt axis and +y axis is parallel to +Xt axis.





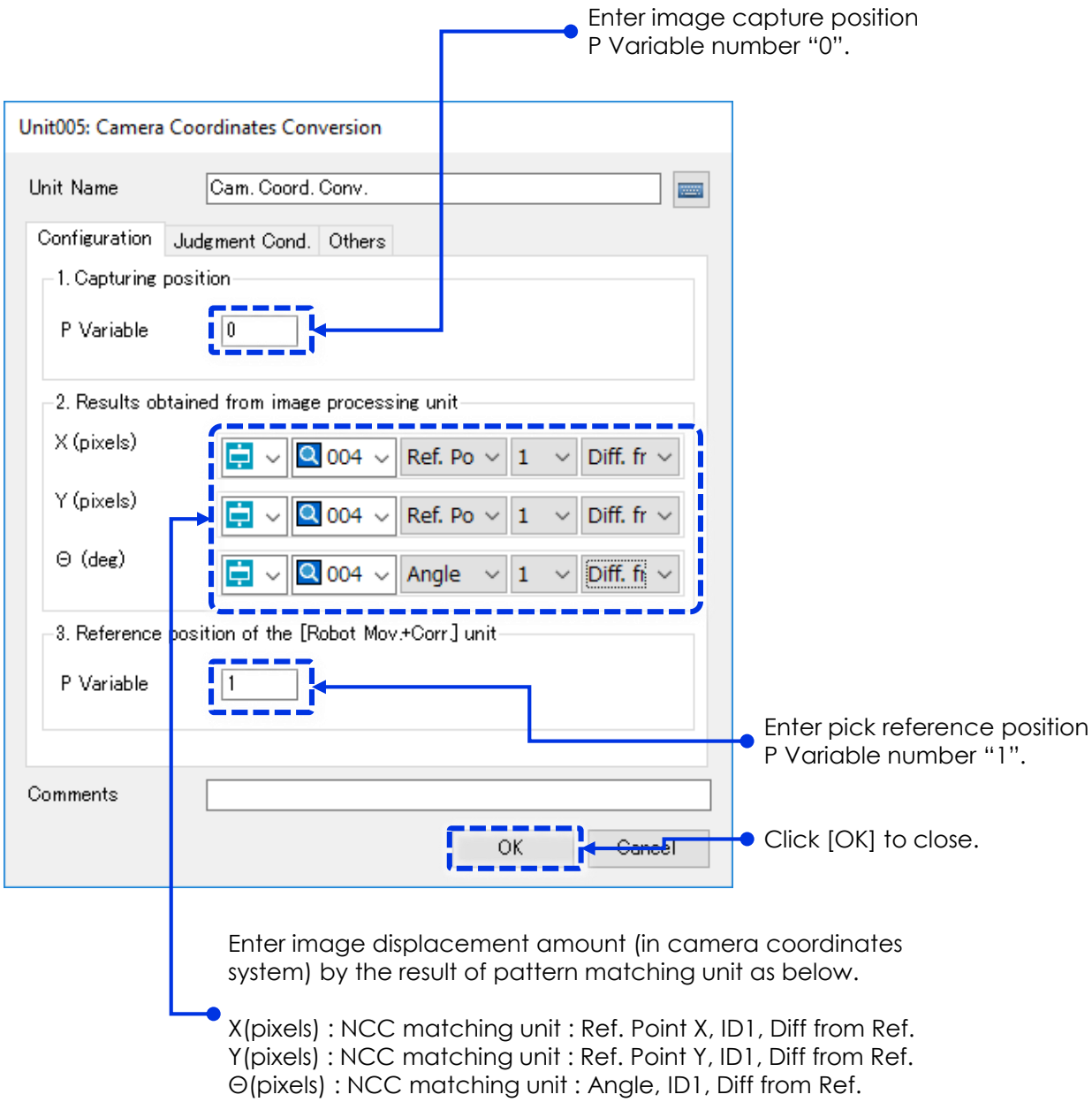


To calculate the displacement from Image A as shown in the left, vector adjustments below are required. (Assuming J6 is set to 0° at pick reference position and only Xt, Zt movement used to arrive to image capture position.)

Robot tool Xt correction = y1 - y0
Robot tool Yt correction = -(x1 - x0)
Robot tool Rzt correction = -(θ1 - θ0)

However Vision Edition ver 1.4.1 supports new [Camera Coordinates Conversion] unit which converts displacement amount between the two coordinates system as long as their x/y and Xt/Yt plains are in parallel.
Thus it eliminates the requirement of J6 angle reset at pick reference position and restriction of movement to arrive to the image capture position.
To do this, both pick reference position and image capture positions are saved as P variables in the robot memory and used in this unit.

1 Configure [Camera Coordinates Conversion] unit.



(8) Setting the robot move destination correction

The robot arm is instructed to move to the pick position by calculated displacement amount from the pick reference point P1. The displacement amount is derived from the result of pattern matching with [Camera Coordinates Conversion] unit calculation and pixel/mm conversion.

1 Configure [Robot Mvmt with Correction] unit.

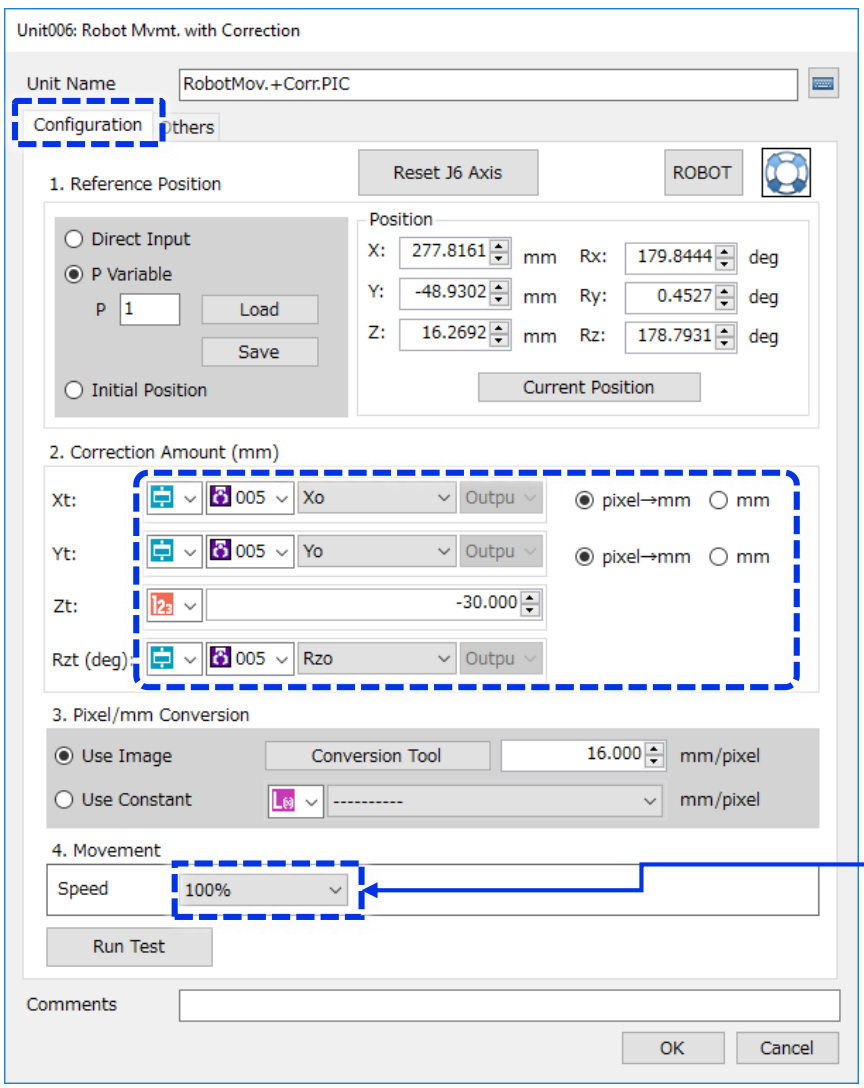
Double-click [RobotMov. + Corr.PICK] unit.
On the [Configuration] tab enter the following parameters.

[Xt]: , 005: Cam. Cood. Conv., Xo, select "pixel - > mm"

[Yt]: , 005: Cam. Cood. Conv., Yo, select "pixel - > mm"

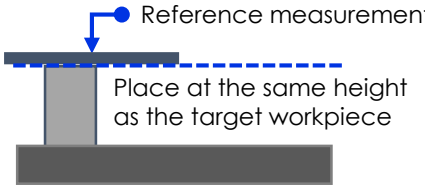
[Zt]: , -30.000"
(30 mm is the approach height to the P1 pick position. Adjust this value depending on the workpiece/pick area environment.)

[Rzt]: , 005: Cam. Cood. Conv., Rzo



2 Convert the image processing values (pixels) to actual dimensions (mm).

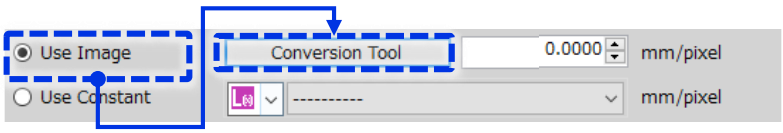
1. Place a ruler on the surface of the workpiece (height of the pick position).
In this example, a mini bottle cap is the height of the pick position.
As long as the height is correct, the X-Y position of the ruler is not important. However, in order to ensure an accurate conversion, a longer measurement length is recommended.



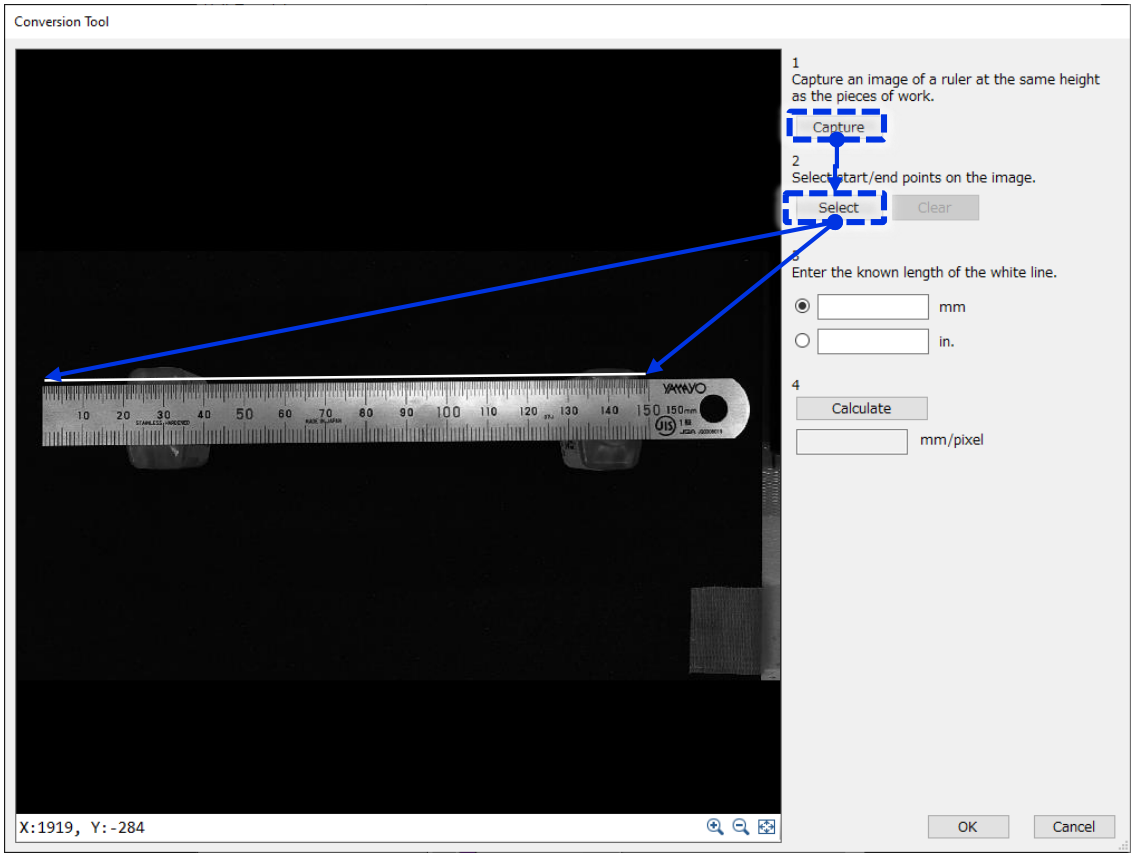
Note

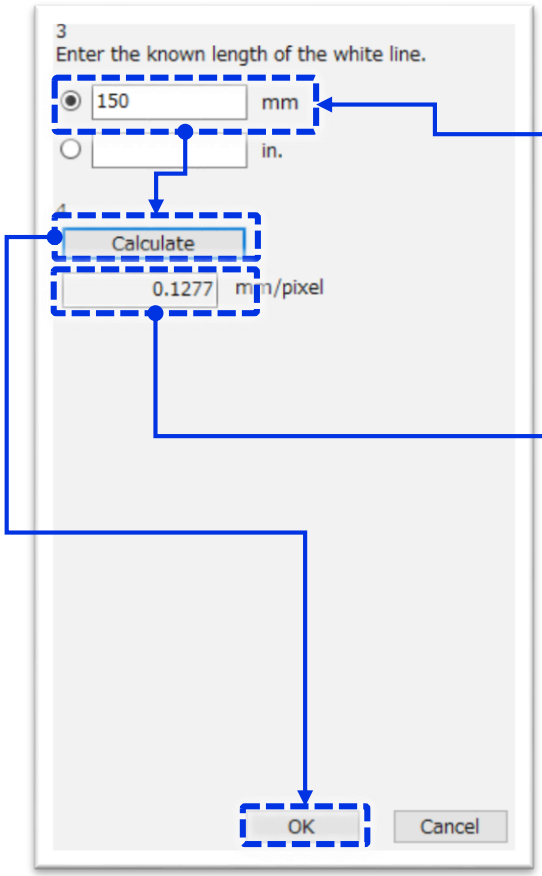
If the ruler is not placed at the correct height, the mechanical shift amount calculated from the pixels will be incorrect, and the robot arm will not be able to reach correct pick position.

2. Select [Use Image] for pixel/mm conversion, then click [Conversion Tool].



3. The [Conversion Tool] screen is displayed.
(1) Click [Capture] to display the ruler. Since the ruler is at the same height as the workpiece, it should be in focus.
(2) Click [Select]. Mouse left-click to drag a line along the length of the ruler, then right-click to fix the points. Draw the line along the edge of the ruler so that the actual length of the line can be easily read.
* If the ruler is overexposed when captured and the scale cannot be read, create and set up a different capture unit.





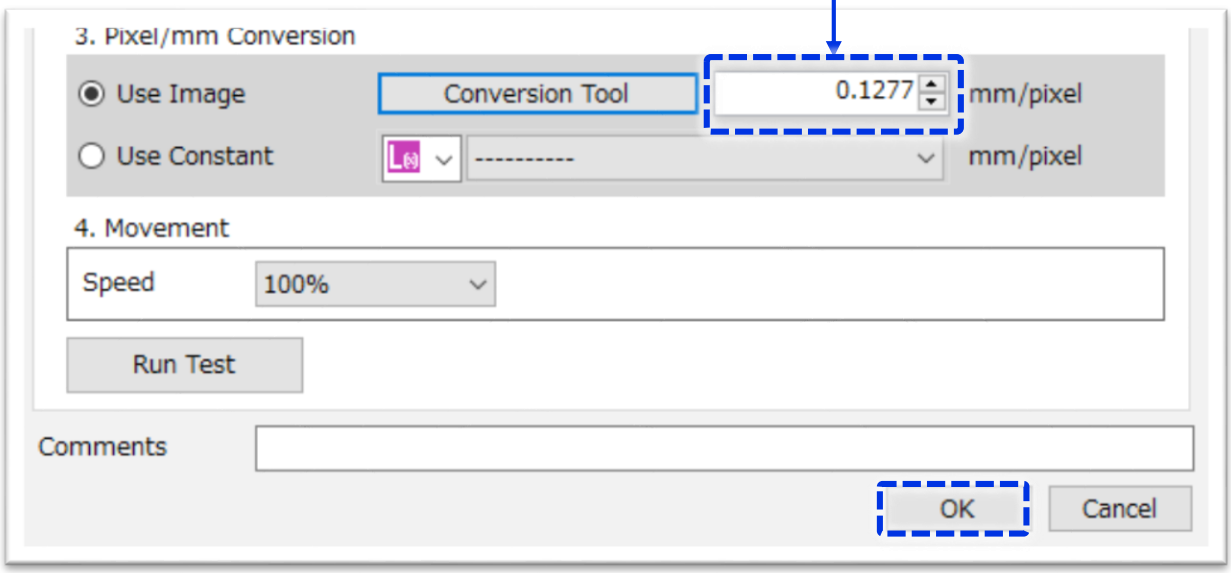
(3) Click [mm] and enter the length of the line.

(4) Click [Calculate] to obtain the mm/pixel conversion value.

(5) Click [OK] to close the [Conversion Tool] screen.

The calculated value is automatically entered in this box.

4. Confirm mm/pixel conversion value displayed to the operation unit. Click [OK] to close.



(9) Setting the robot descend movement

Using relative position movement (from the initial position), set the descent amount and speed for moving the arm to the pick position. Enter the same descent amount as the approach amount that was used for the [RobotMov. + Corr.PICK] unit.

Double-click [RobotMov. + Corr.DES] unit. On the [Configuration] tab:

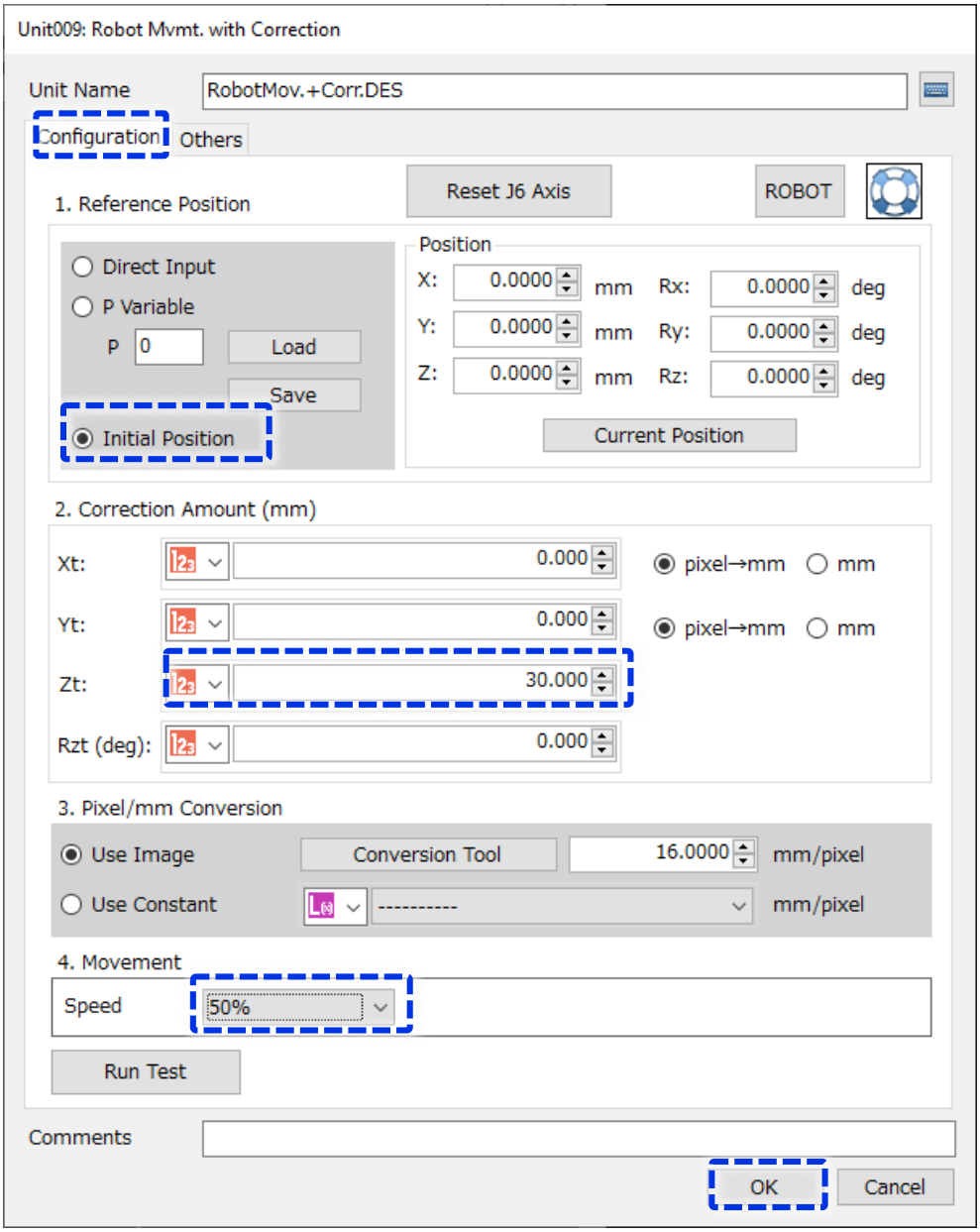
Select [Initial Position] under [1. Reference Position].

Enter the values for [2. Correction Amount (mm)].
[Zt]: Real Number , "30.000"

(30 mm is the same amount as the approach height for the [RobotMov. + Corr.PICK] unit. The robot arm lowers 30 mm to reach the P1 position.

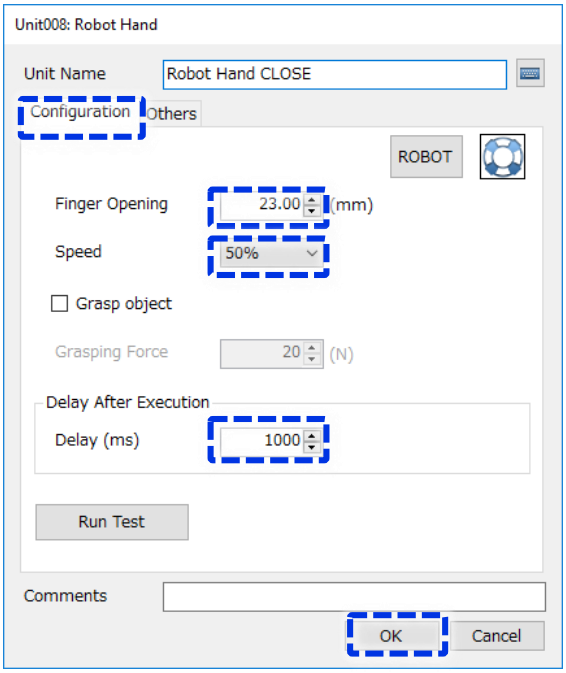
Enter 50% for [Speed] under [4. Movement].

Click [OK] to close the screen.



(10) Setting the robot hand and ascend movement

Configure the robot hand unit so that it holds the workpiece.
Configure the [Robot Mov.+Corr. ASC] unit so that both the robot arm and workpiece move safely away from the pick area.



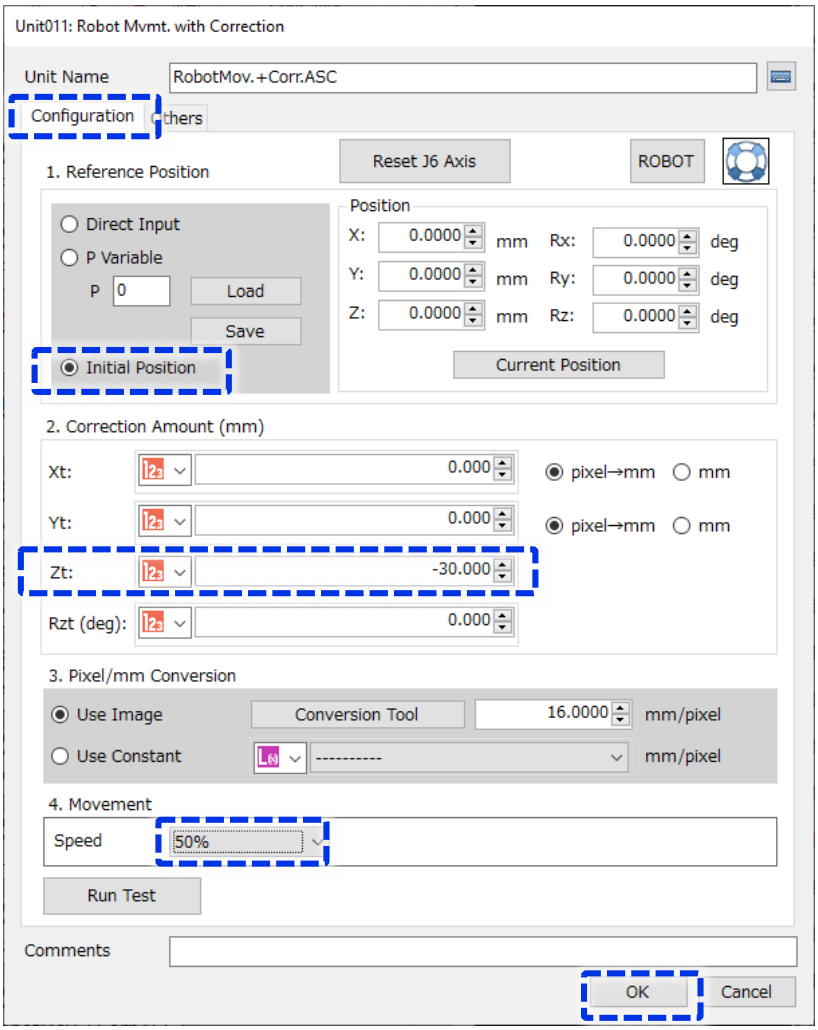
Double-click [Robot Hand: Robot Hand CLOSE]. On the [Configuration] tab:

Enter the hand length recorded in step (2) for [Finger Opening.]

[Speed]: 50%

[Delay]: 1000 ms

Click [OK] to close the screen.



Double-click [Robot Mov.+Corr. ASC] unit.

On the [Configuration] tab:

Select [Initial Position] under [1. Reference Position].

Enter the values for [2. Correction Amount (mm)]
[Zt]: , -30.000

(Enter a suitable height for the robot arm to rise and move to the next position, without interfering with any other workpieces in the pick area.)

Enter a value for [4. Movement]
[Speed]: 50%

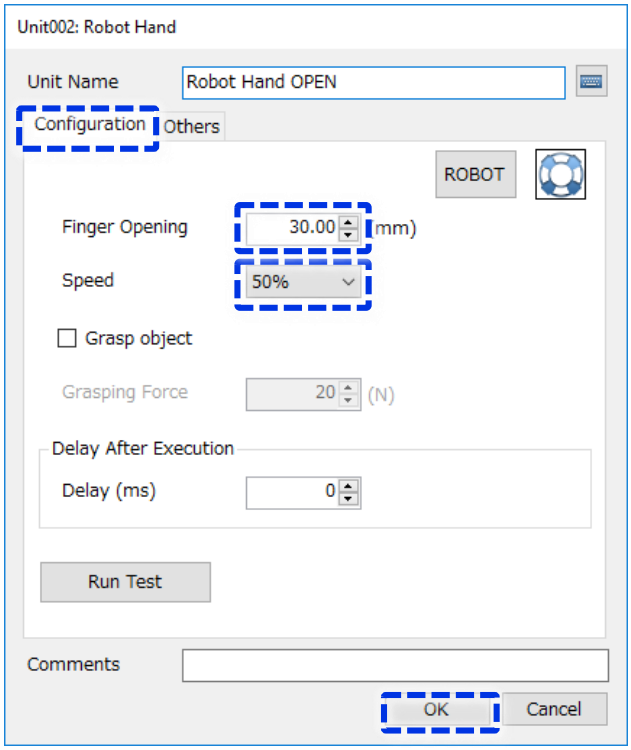
Click [OK] to close the screen.

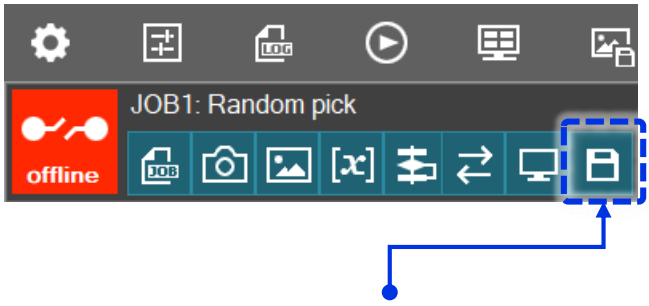
Double-click [Robot Hand: Robot Hand OPEN] unit, which is the first unit on the flowchart. On the [Configuration] tab:

The value for [Finger Opening] should be sufficiently large enough not only for the robot arm to lower to the pick position without touching the workpiece to be picked, but also without interfering with any other workpieces in the pick area.

[Speed]: 50%

Click [OK] to close the screen.





Click [Save current job settings] to save the job.

(11) Running the job

Before running the entire job as a test, check each operation unit.
Robot control units in particular should be checked.

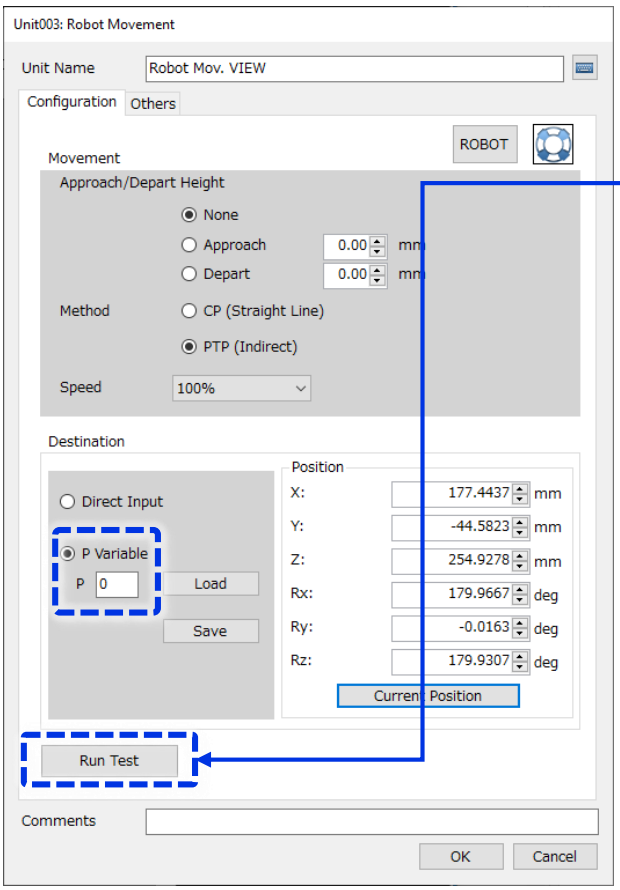
1 Check each unit.

If it is configured correctly, this job should perform the following steps of the flowchart operation units.

1. The robot hand opens.
2. The robot arm moves to the "image capture position (= P0)".
3. The workpiece image is captured in the pick area.
4. NCC pattern matching is performed to detect the random pick position and angle of the workpiece.
5. Correction amount Xt, Yt, Rzt is calculated from the coordinates detected from pattern matching (=difference from the master image's pick reference point).
6. The robot arm moves to the random pick approach position.
7. The robot arm descends to the random pick position (= P1 with correction amount).
8. The robot hand closes, grabbing the workpiece.
9. The robot arm rises to a sufficient height to perform the next movement.

Robot control units to perform step 1, 2, 6, 7, 8 and 9 have a [Run Test] function that allows an operation test to be conducted for each unit individually.

First, open the units for step 1, 2 and 8 and click [Run Test] to make sure that the robot moves correctly. (Use Remote TP/Virtual TP to set the external speed for the robot arm to 30% or less, and prepare the emergency stop button at hand to immediately stop the robot in the event of unexpected movement.)



In this example, by clicking [Run Test], the robot arm moves to the P0 position (=image capture position).

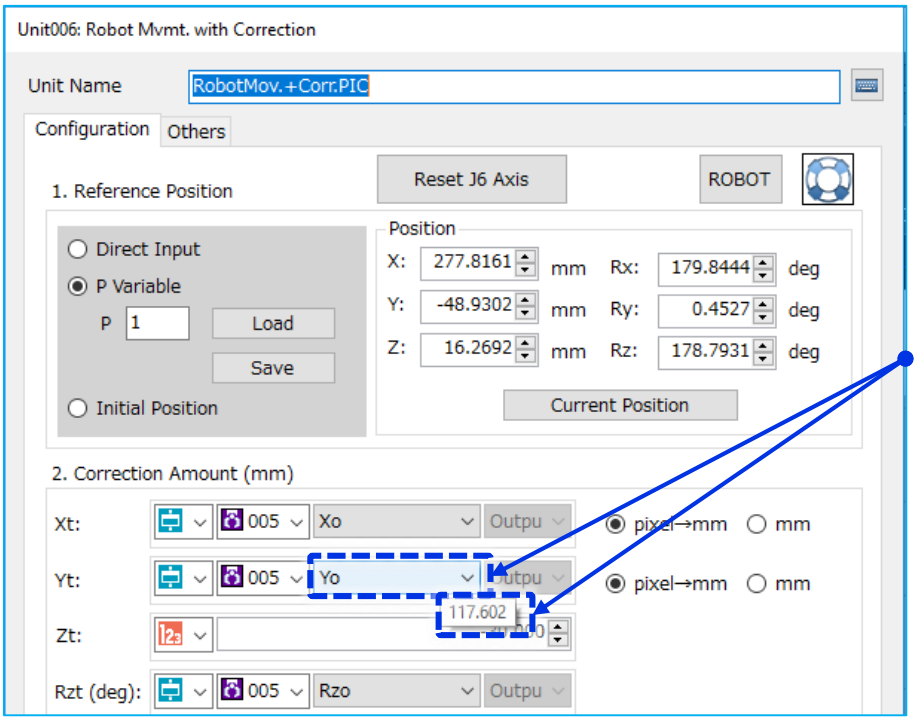
Note

[Run Test] (=to move to P0) is convenient method for checking the settings of the capture unit and the NCC matching unit.
Before opening the capture unit or the NCC matching unit, use this operation to send the robot arm to the image capture position.

Also, if it is necessary to release the workpiece, open the hand open unit and click [Run Test].

The results of [Run Test] for [RobotMov. + Corr.PICK] in step 6 will vary according to the result of [Camera Coordinates Conversion] unit and can be checked by the below method.

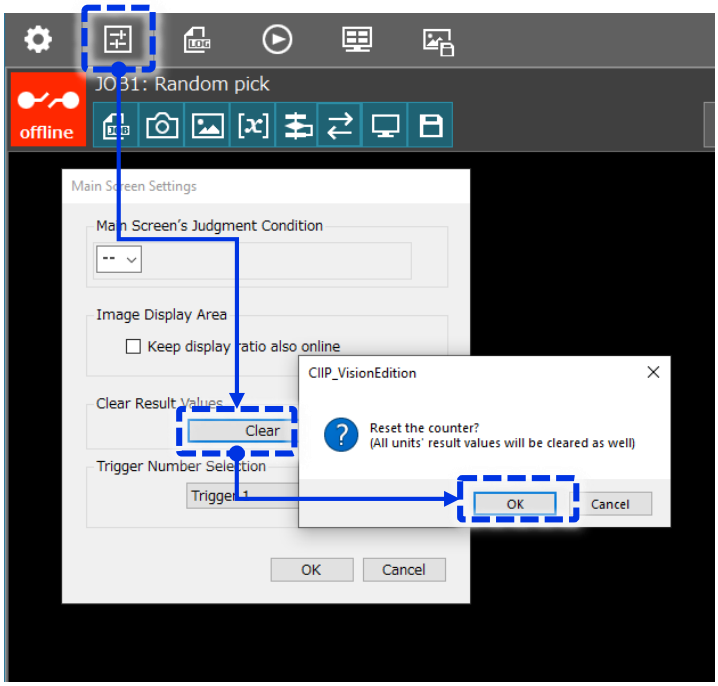
In addition, the movement in steps (7) and (9) is relative to the previous (= current) robot arm position, therefore should pay particular attention what is the current position before testing.



Hover the mouse cursor over Xo/Yo/Rzo and result (pixel amount) will be displayed.

If the correction amounts for Xt, Yt, and Rzt are not zero, clear by following operation.

Click [Main Screen Settings], then click [Clear] under [Clear Result Values].
Click [OK] in the message window. Click [OK] to close Main Screen Settings.



This clears all processing results (calculation values) for each unit.

If click [Run Test] on the [RobotMov. + Corr.PICK] unit, the robot arm moves to the "P1 + Approach" position.

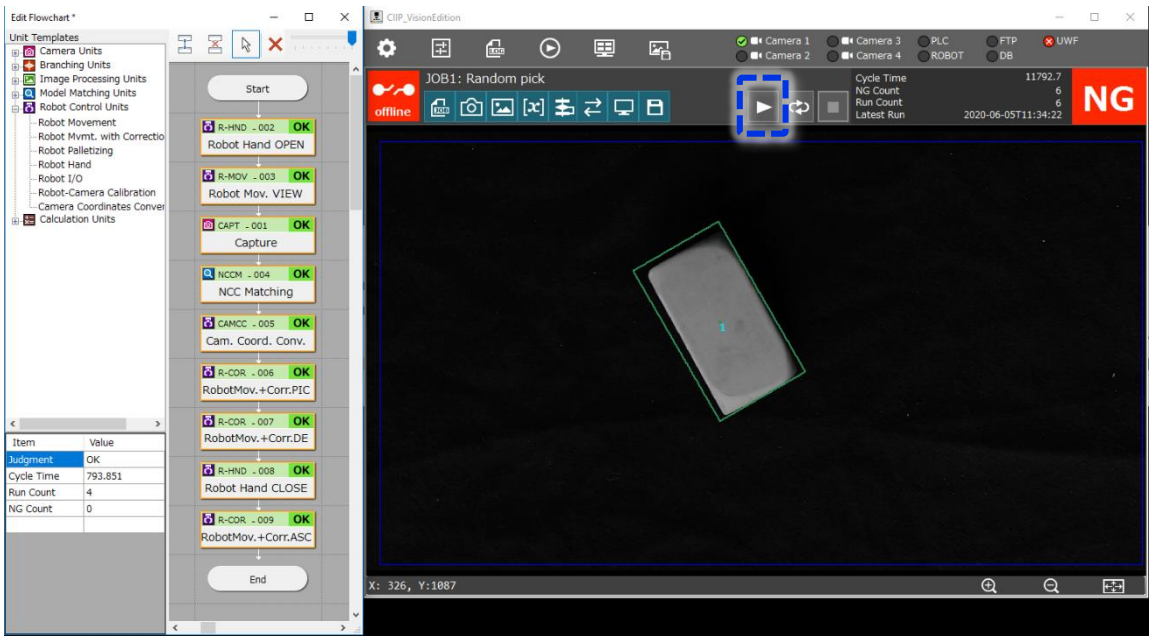
2 Run the job.

Click the [Trigger] button on the top right, to run the created flowchart.

Note

The following preparations are recommended in case of unexpected movement of the robot.

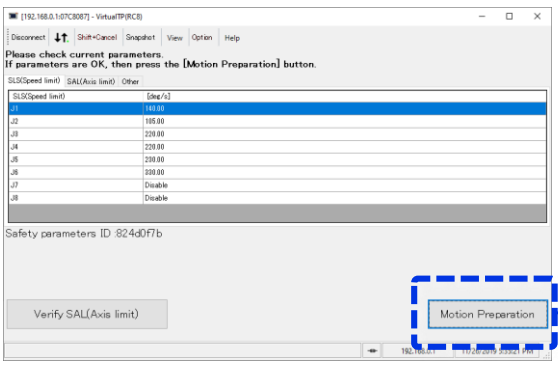
- Use Remote TP/Virtual TP to set the external speed of the robot arm to 30% or less.
- Place the robot's emergency stop button nearby to press it at any time.



If the job runs correctly, the result for the flowchart operation units should be OK.
In this example, the result displayed in the upper right corner is NG, but that is merely because of the default settings.
Set appropriate judgment conditions at [Main Screen Settings] if necessary.

Process of pressing the emergency stop button

- Press the emergency stop button on the robot.
- The following screen appears in Virtual TP. Execute the operation preparation.
- Change to direct teaching or change the executable token to TP, and move the robot from the current position.



Check each parameter, then click [Motion Preparation].

Chapter 2

Procedure for picking an asymmetric workpiece

Picking & placing an asymmetric workpiece

In Chapter 1, it was assumed that the target workpiece being picked was symmetrical.
As of June 2019, the COBOTTA J6 joint rotates up to ±170°. Therefore, depending on the angle of the object, the hand cannot rotate and grab the workpiece even if pattern matching recognizes it. This chapter describes the procedure for handling such cases.

- **Step (1) Create a new job from a template and connect the devices**

  Create the first workflow section by using a flowchart template for pick & place.
  COBOTTA connection is preconfigured in this template and just register the camera.

- **Step (2) Set image capture position and pick reference position**

  Set the image capture position.
  Set the pick reference position for the symmetrical part of the target workpiece.
  Set the hand width to grab the workpiece.

- **Step (3) Creating a model**

  Move to the image capture position and capture the master image of the target workpiece at the pick reference position set in the step (2).
  Create a 180-degree model using the symmetrical part of the workpiece from the master image.
  From the same master image, create a 360-degree model of the entire workpiece.

- **Step (4) Creating a workflow for picking the workpiece**

  Create a workflow from capturing image until picking workpiece.
  Basically, this is the same procedure as Work Support Manual "Pick & Place basic".
  Since this 180-degree model is created on the symmetrical part of the target workpiece, detected angle will be maximum ±90° range with J6 joint rotation angle in the same range.
  Therefore it is possible to pick this asymmetric workpiece at any position and angle.
  However it will not be able to place it in the same direction every time.

- **Step (5) Creating a workflow for changing the orientation of the workpiece**

  Picked workpiece is being placed at the pick reference position in either +90° or -90° rotation from the original target workpiece orientation.
  Place it again in this way makes it possible to pick a workpiece with 360-degree model since J6 joint only need to rotate either +90° or -90°. Picking with 360-degree model means able to place in the specific position / direction of this asymmetrical workpiece. (Except the position over ±170° rotation from the master image.)

- **Step (6) Creating a pick workflow once again for the rotated workpiece**

  Copy and paste the workflow created in step (2) to (4), make partial changes to create a workflow for picking the workpiece with +90° or -90° angle from the pick reference position with 360-dgree model.

- **Step (7) Creating a workflow for the final placement of the workpiece**

  Copy and paste the workflow created in step (5), make partial changes to create a workflow for placing the workpiece in the specific orientation.

- **Step (8) Checking operation**

  Run the entire job to pick and place the asymmetric workpiece.
  Make sure that workpiece is always placed in the same specific position and direction in the end, either it placed same or opposite direction of the master image at the beginning.

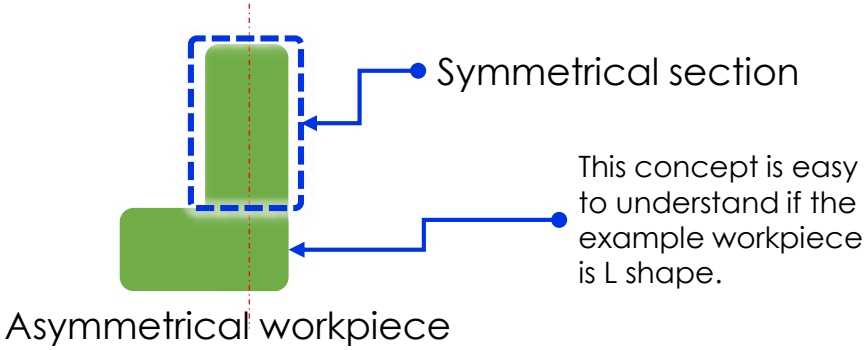
Note

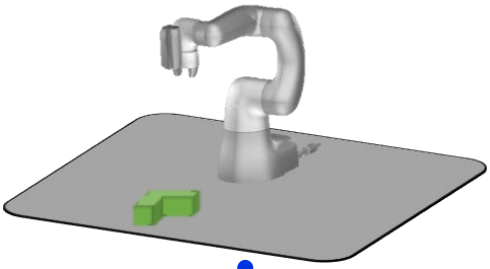
The information in this chapter is provided based on the assumption that the reader has studied the information in the Work Support Manual "Pick & Place basic".
Note that some basic information and duplicate parts have been omitted.

Job workflow

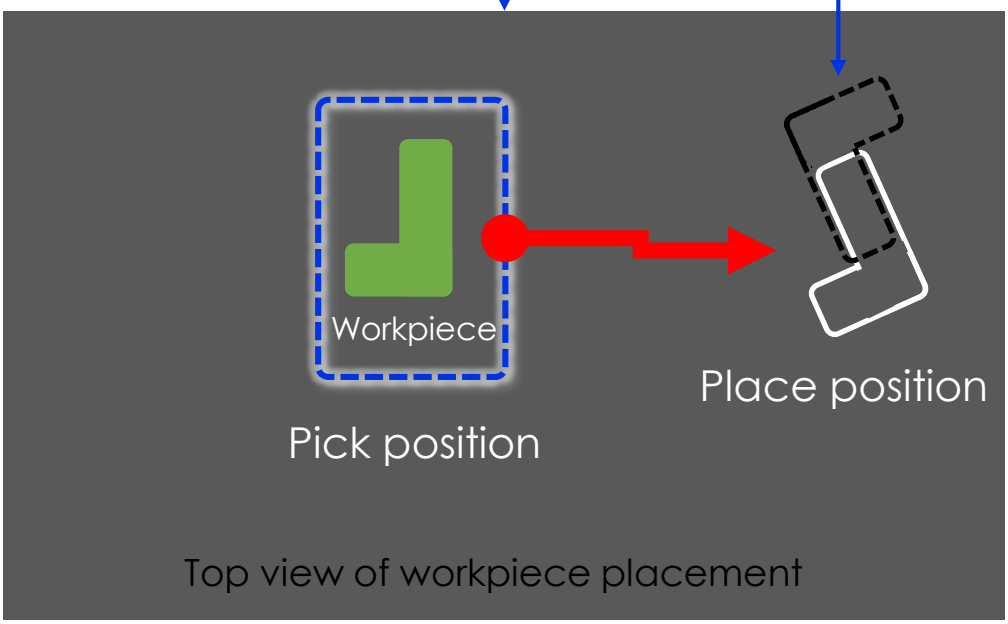
Since J6 joint rotates maximum of ±170°, if 360-degree model of the workpiece is registered, COBOTTA cannot pick it if the detected angle is over ±170°.
If the workpiece is symmetrical, by making 180-degree model it is possible to pick the workpiece as it will be detected between -90° to +90° angle and J6 axis rotation angle range will be the same.
Therefore, it is possible to pick even an asymmetrical workpiece by using its symmetrical areas to create 180-degree model.

However, if you want to always place an asymmetrical workpiece in a specific orientation, need to re-place it again for 360-degree model to pick it up for the final placement.
This section describes how to create a job for such procedure.





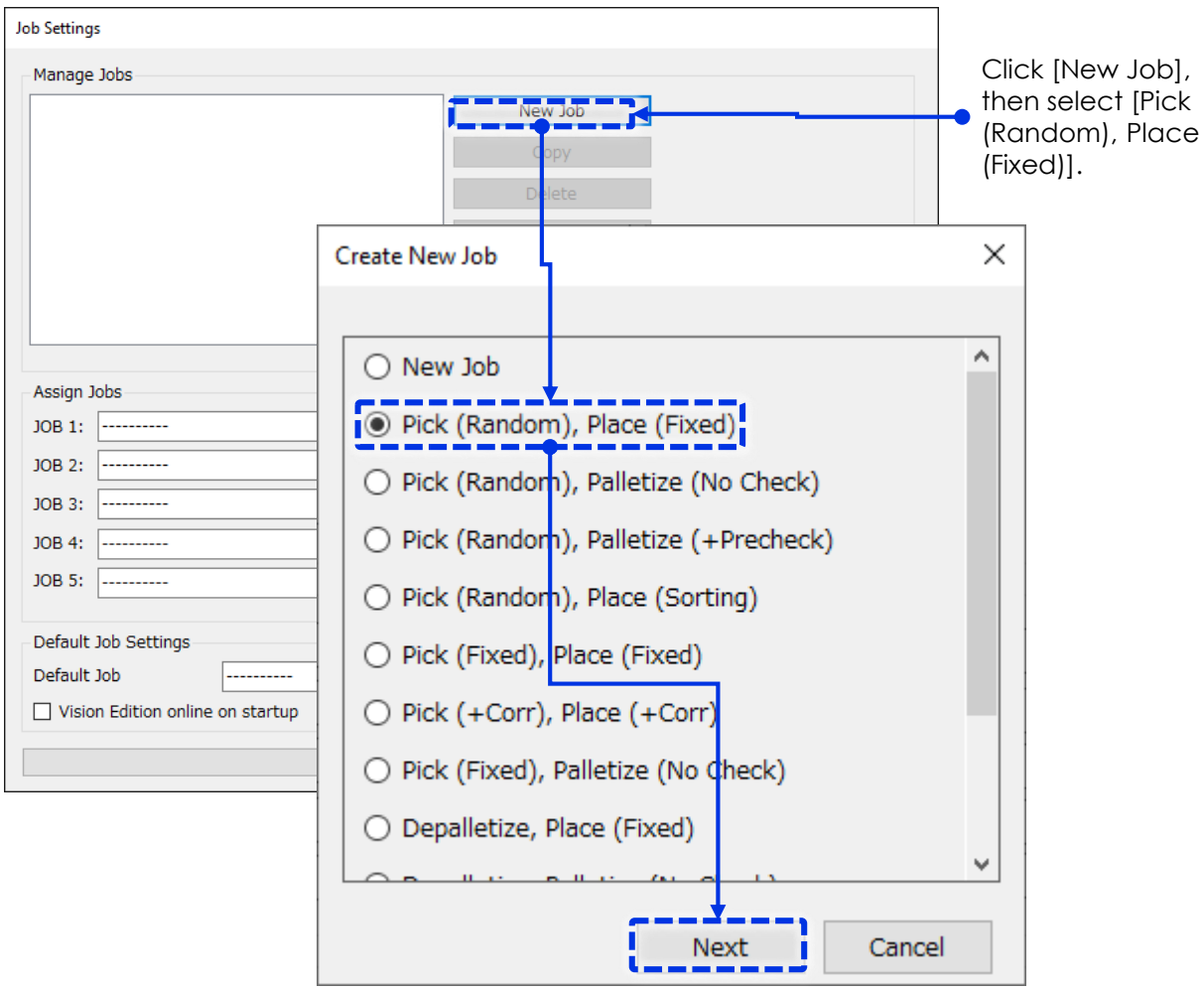
If picking is by 360-degree model based on entire shape, it may not be able to pick up always.
If picking is by 180-degree model based only on symmetrical part, it can be picked up always but not possible to place to the position (direction) specified by the white line.
Depends on the pick workpiece angle and the detection, final placement may be opposite direction as black dotted line. Therefore it requires combination of both method.



(1) Create a new job from a template and connect the devices

Create the first workflow section by using a flowchart template for pick & place.
COBOTTA connection is preconfigured in this template and just register the camera.
* For more information, refer to the Work Support Manual "Pick & Place basic".

1 Click the job button. When the [Job Settings] screen opens, click the [New Job]. From the templates, select [Pick (Random), Place (Fixed)]. (Change the name as required.)
Open the new job.



Click [New Job], then select [Pick (Random), Place (Fixed)].

2 Register the camera.

The default settings for the N10-W02 camera are shown below.
IP Address: 192.168.0.90
User Name: admin
Password: password

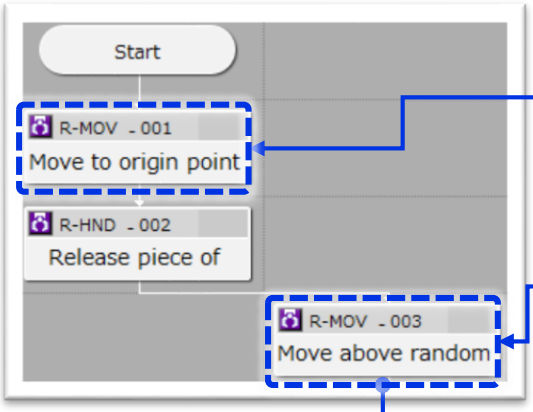
Note

The connection to the COBOTTA robot is already configured in this template.

(2) Set image capture position and pick reference position

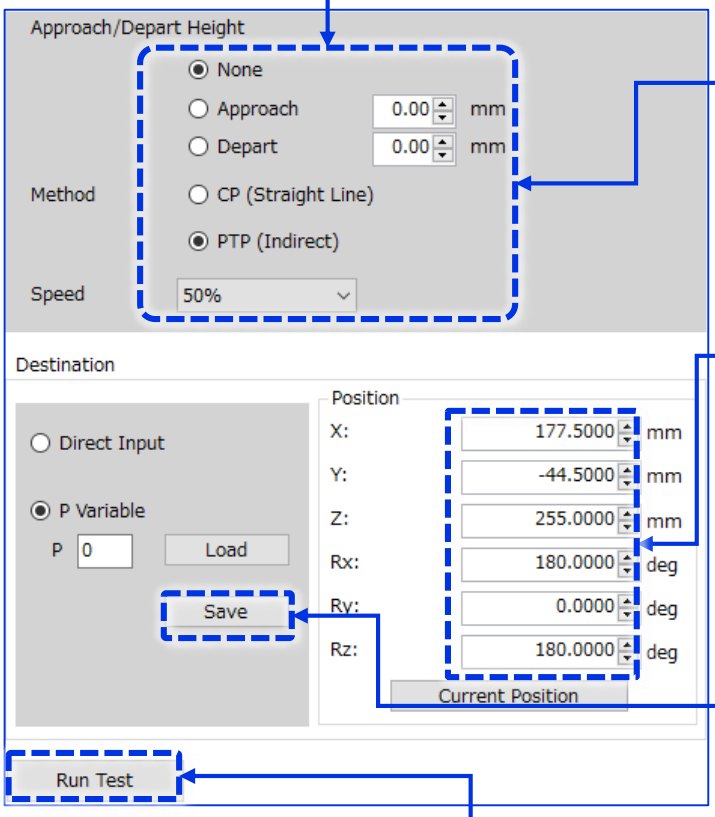
Set the image capture position and pick reference position.
Set the center of the symmetrical portion of the workpiece as the pick position, not the center of the entire workpiece.
* Robot arm movement to the origin point has been omitted here for simplicity.

1 Set the image capture position.
To make it simple, [001 Move to origin point] and [018 Move to origin point] unit in the original sample job will not be used and deleted them.



Delete [001 Move to origin point] unit.
Connect [Start] to [002 Release piece of work] unit.
Delete [018 Move to origin point] unit at the end of the flowchart.
No need to reconnect this unit at this stage.

Open [003 Move above random] unit.



It is not necessary to make any changes to these settings.

Enter the following coordinates accurately in the input fields for the image capture position.

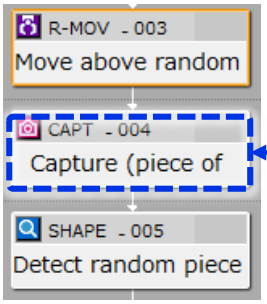
X= 177.5
Y= -44.5
Z= 255
Rx= 180
Ry= 0
Rz= 180

Click [Save] to save to P Variable P0.

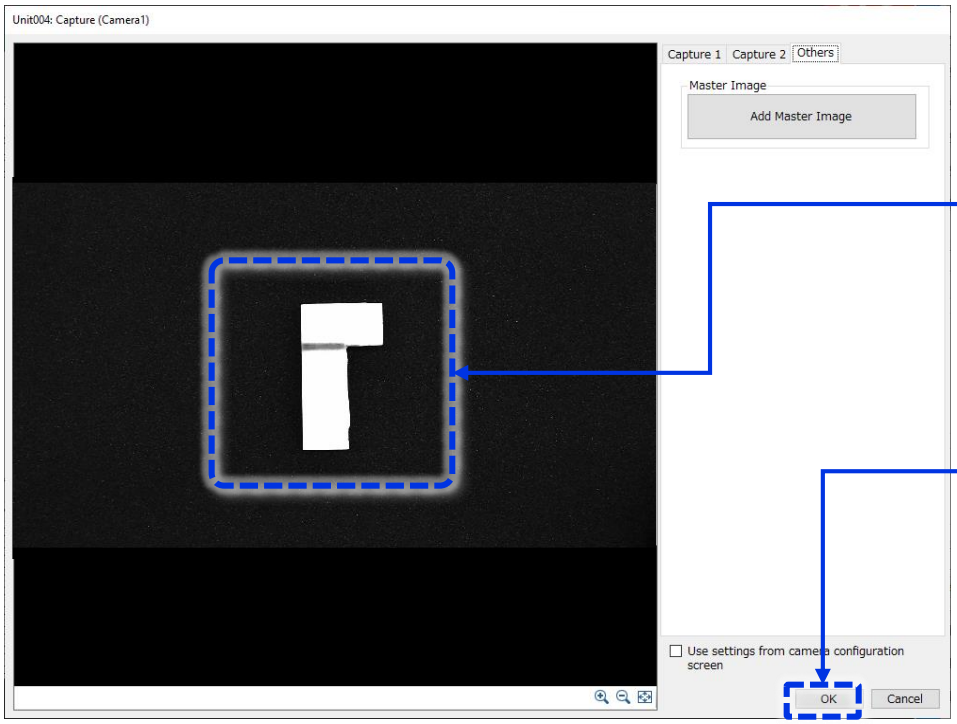
After saved to P0, click [Run Test] to move robot arm to the image capture position.

Click [OK] to close.

2 Arrange the workpiece to roughly center of the capture screen.
In order to make good matching model, use a black non-reflective sheet as the background for the preparation of master image and model creation.



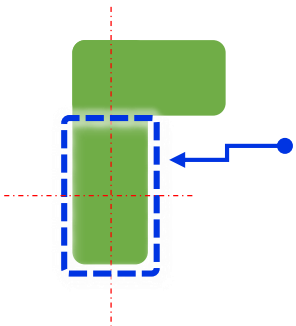
Open [004 Capture] unit, click Camera1 [Configure].



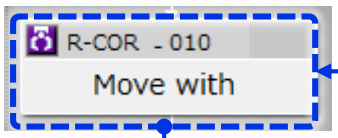
Place the workpiece near the center.

Once placed the workpiece, click [OK] to close the unit.

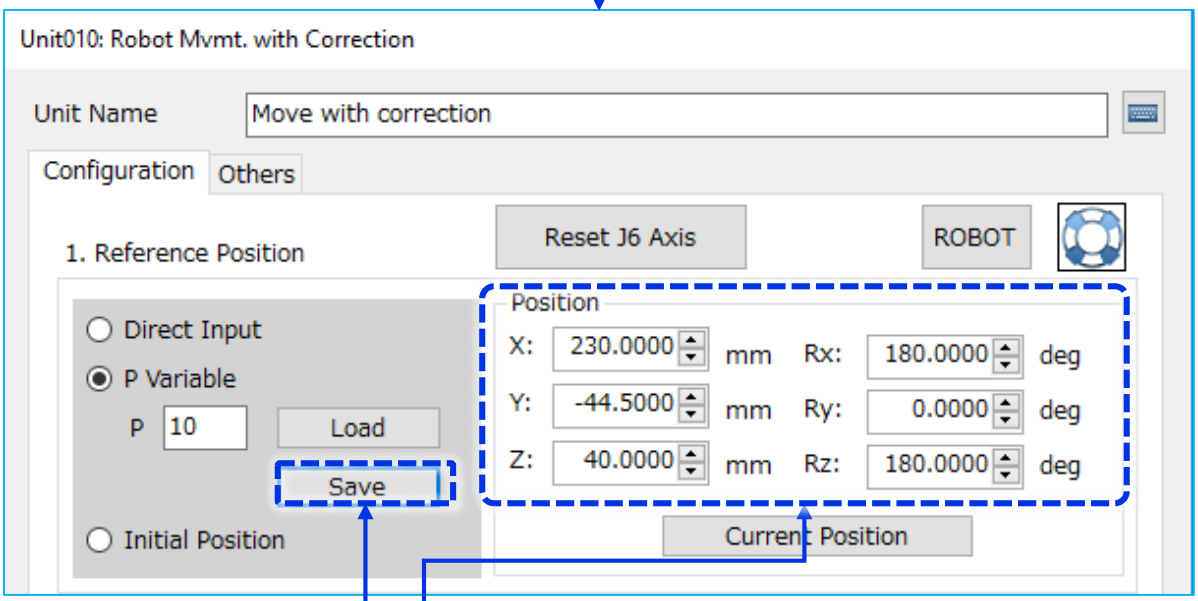
3 Move the robot arm to the position to grab the target workpiece.
Make sure that the robot grabs the center of the symmetrical section of the workpiece.
First, open [010 Move with Correction] unit.



Symmetrical section



Open [010 Move with] unit.

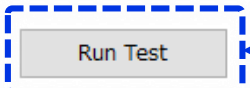


Enter the following coordinates accurately in the input fields for pick reference position setting.

*Note : Z height depends on the height of the target workpiece and use larger value such as 60mm if using tall / thick target workpiece.

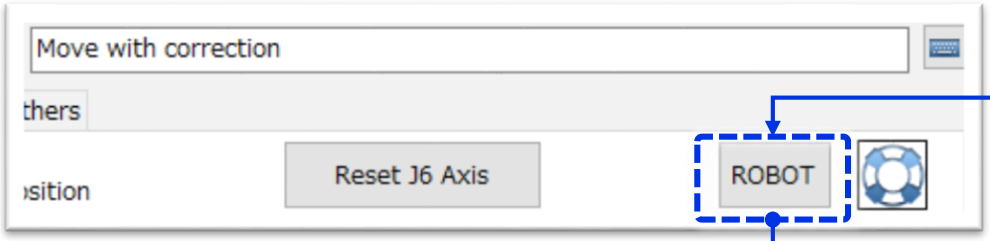
X= 230.0
Y= -44.5
***Z= 40.0**
Rx= 180
Ry= 0
Rz= 180

After entering the coordinates, click [Save] to save to P Variable P10.

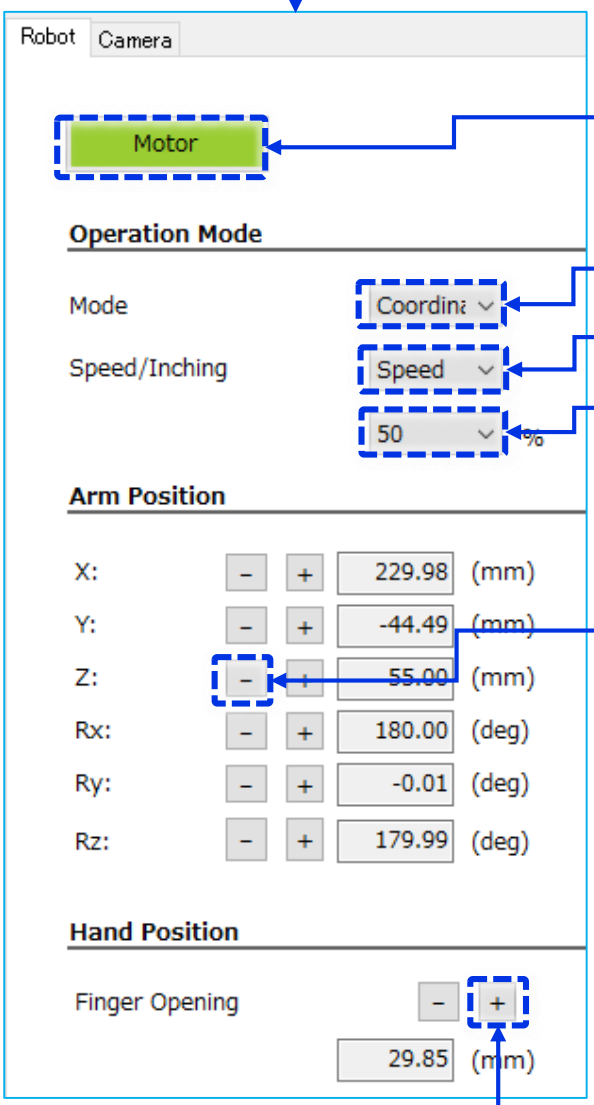


Click [Run Test] to move the robot arm to this position.

Adjust arm height by operating Z[-] a little at a time to the actual grab position.



Click [ROBOT] button.



Click the [Motor] button.
If this button is green, the motor is on.

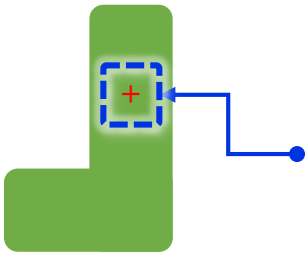
Leave as [Coordinates].

Leave as [Speed].

Set to [50%].

Click the Z[-] button as many times as required to lower the robot arm position to suitable height for grabbing the workpiece.

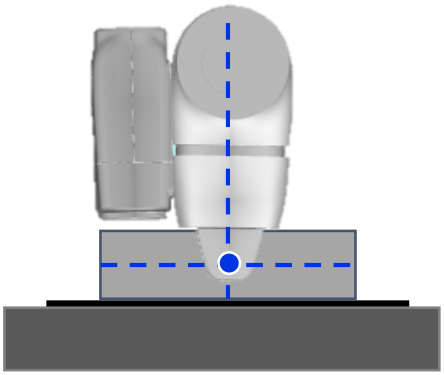
Once the robot arm has been lowered to appropriate approach height, adjust the position of the workpiece so that the center of its symmetrical portion and the center of the robot hand are aligned.

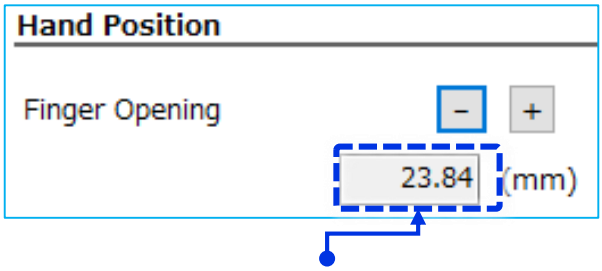


Symmetrical section

If the finger opening is not wide enough, adjust to open before descend the robot arm to the actual grab height on next page.

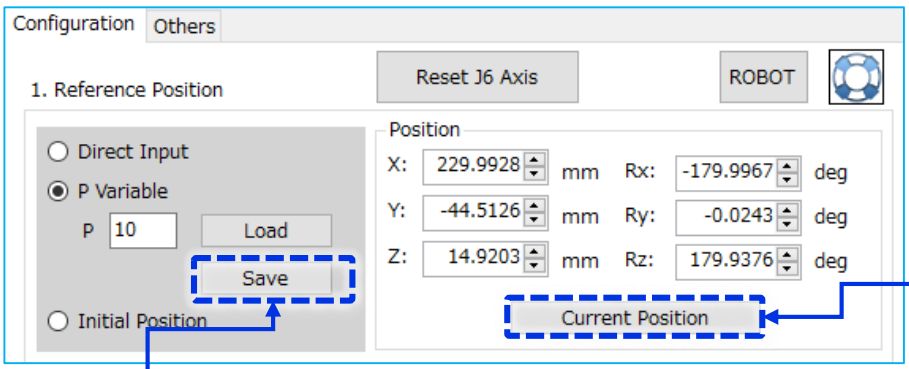
4 Carefully click Z[-] button to lower the hand to the height to grab the workpiece. Operate the finger opening of the hand to securely grab the workpiece and make a note of the width.
Open the hand again to release the workpiece but making sure it does not move the position.





When the workpiece is grabbed, make a note of the finger opening of the hand.

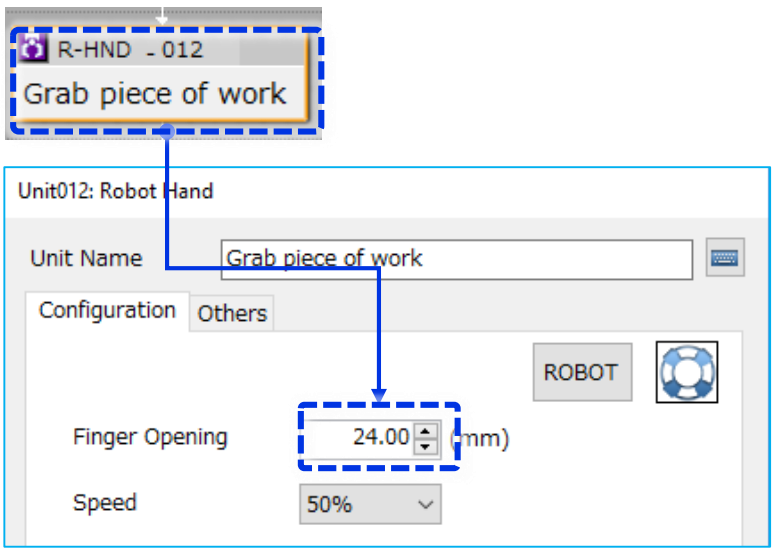
5 Close the robot operation dialog, click [Current Position] on the [010 Move with Correction] unit and save it to robot's P10 memory. This becomes pick reference position.



Click [Current Position].

After getting current position value, click [Save] to overwrite P10.
Click [OK] to close.

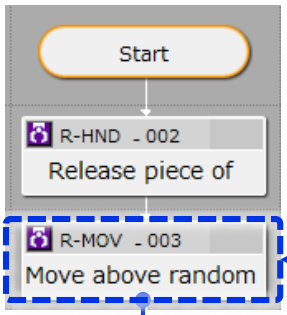
6 Enter the finger opening value taken at the previous process to the [012 Grab piece of work] unit.



(3) Creating a model

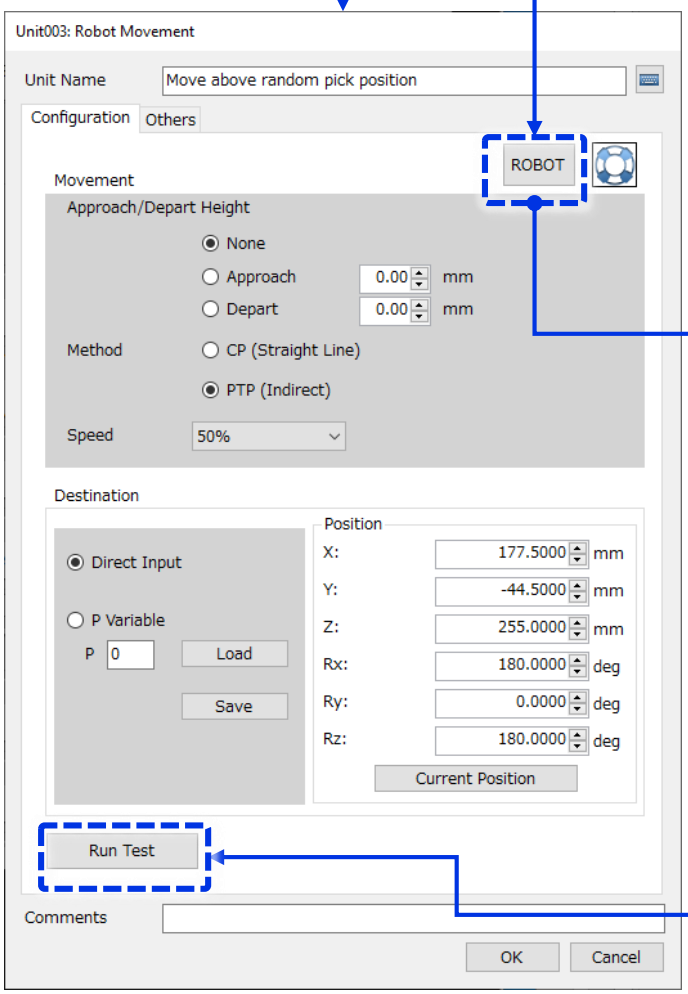
Move to the image capture position and capture the master image of the target workpiece at the pick reference position set in the step (2).
Create a 180-degree model using the symmetrical part of the workpiece from the master image.
From the same master image, create a 360-degree model of the entire workpiece.

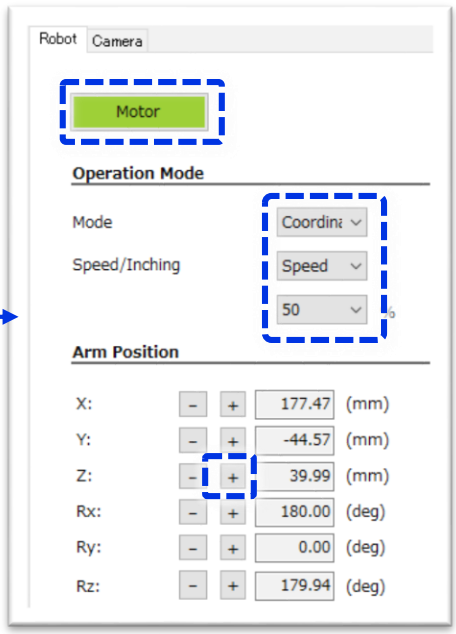
1 Move COBOTTA to the capture position that was set in the previous step (2).
First, operate the [ROBOT] and [Z+] buttons in the [003 Move above random pick position] unit to raise the robot arm from the pick reference position while making sure the workpiece is not moved.
Then click [Run Test] to move to the image capture position.



Open [003 Move above random pick position] unit.

First click [ROBOT] to open robot control window and operate Z[+] to clear the hand from the target workpiece.

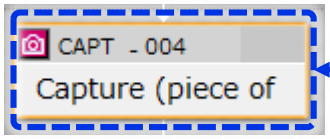




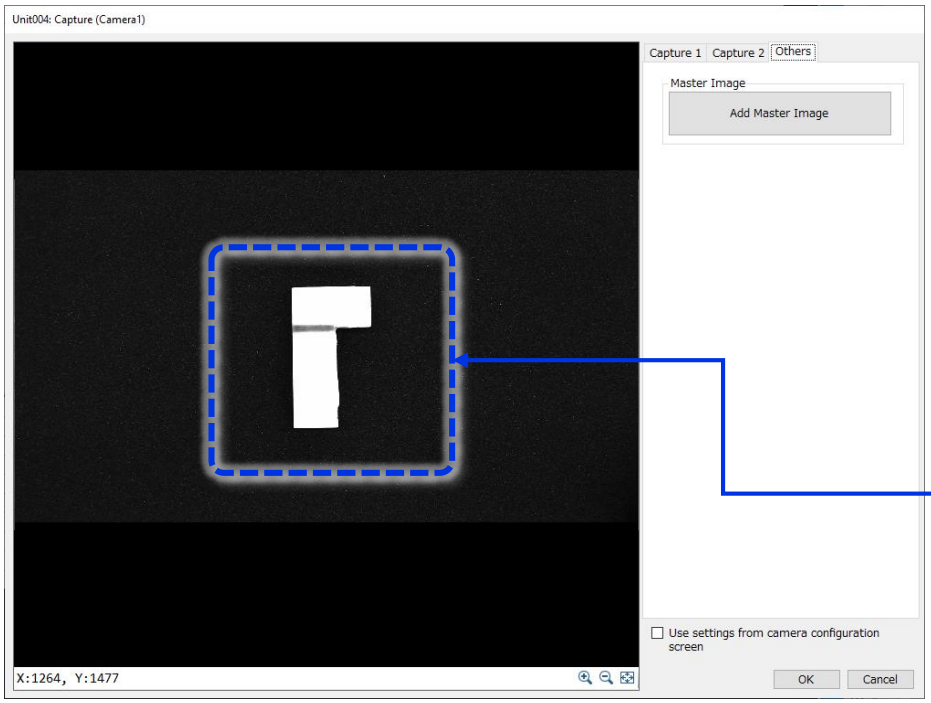
Click [Run Test] to move the robot to the image capture position.

Click [OK] to close.

2 Configure the capture settings.

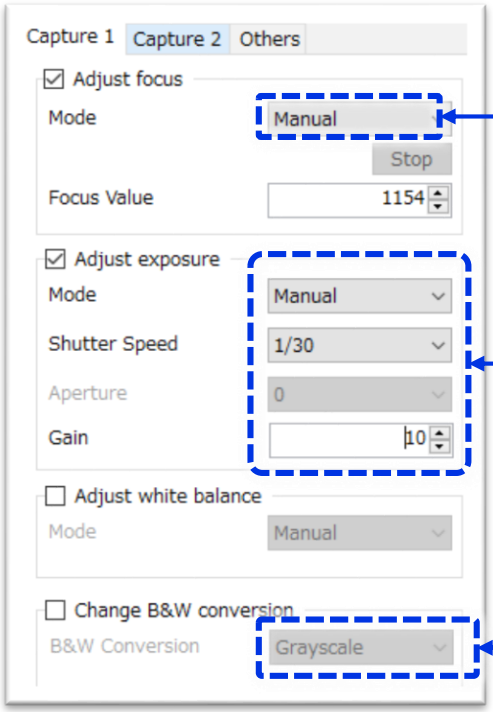


Open [004 Capture] unit.
Click Camera1 [Configure]



Do not move the workpiece.

3 Capture the workpiece and register the master image.
First, configure the capture settings as shown below.

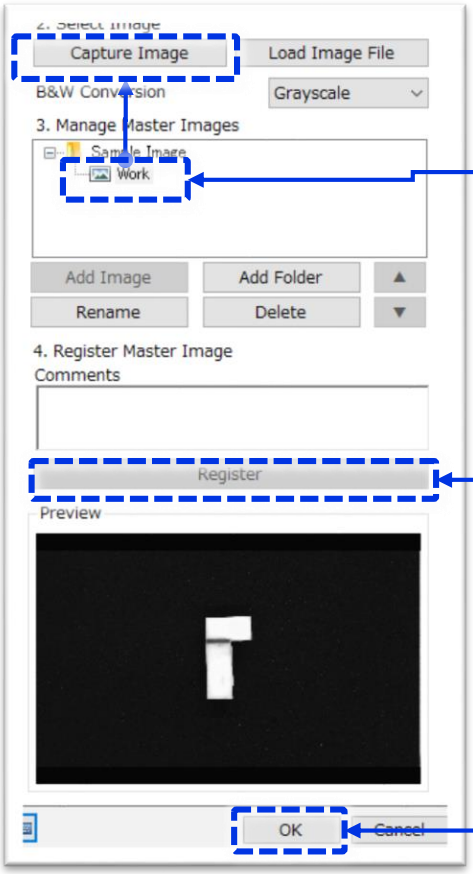


Tick box and set to [One-Shot AF] to align the focus position with the workpiece.

Tick box and set [Auto] or change to [Manual] to adjust to obtain clear edges of the object.

Tick box and set to [Grayscale].

4 Register a master image.
Refer page 29 for detailed instruction.



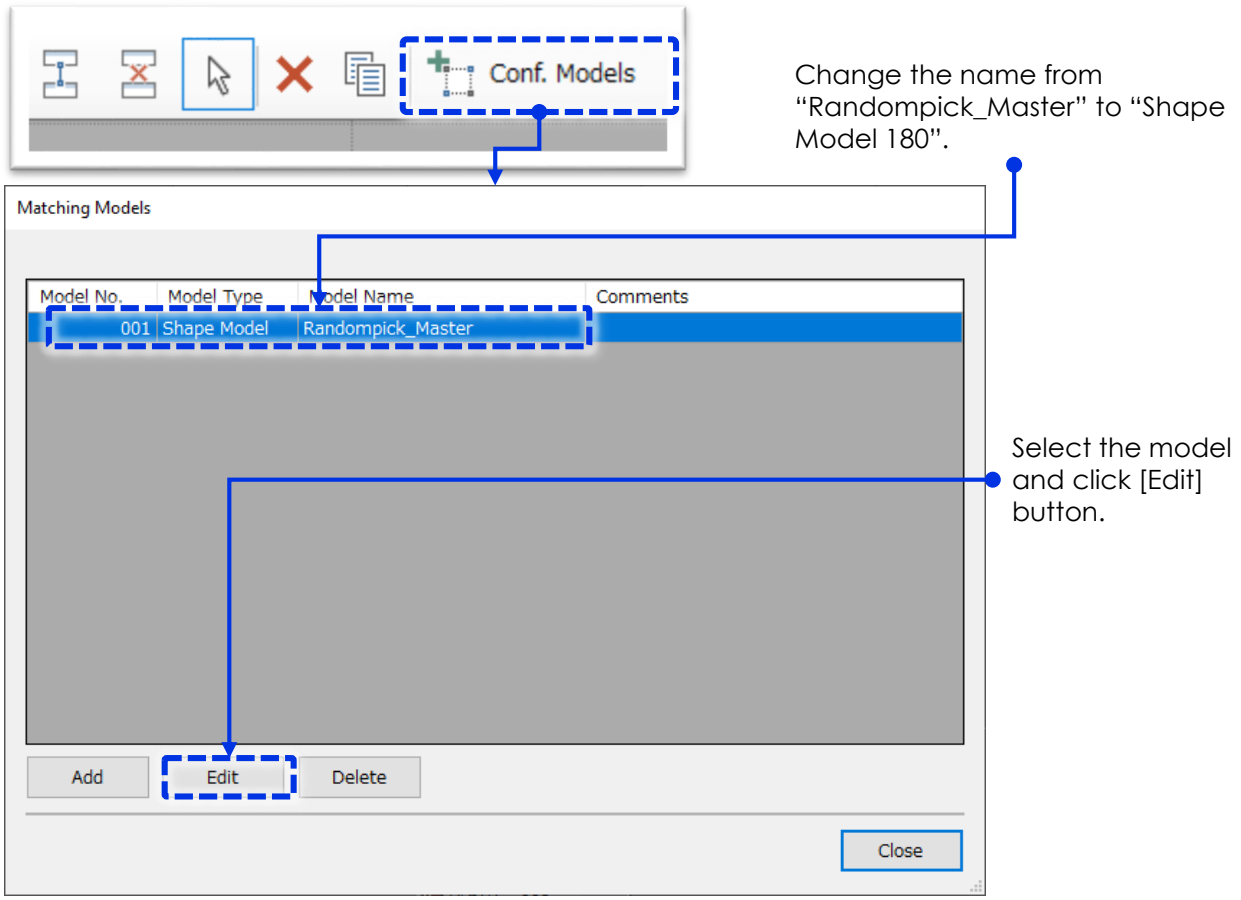
Select master image file, then click the [Capture Image] button.

* For this example, the image file name has been changed to [Work].

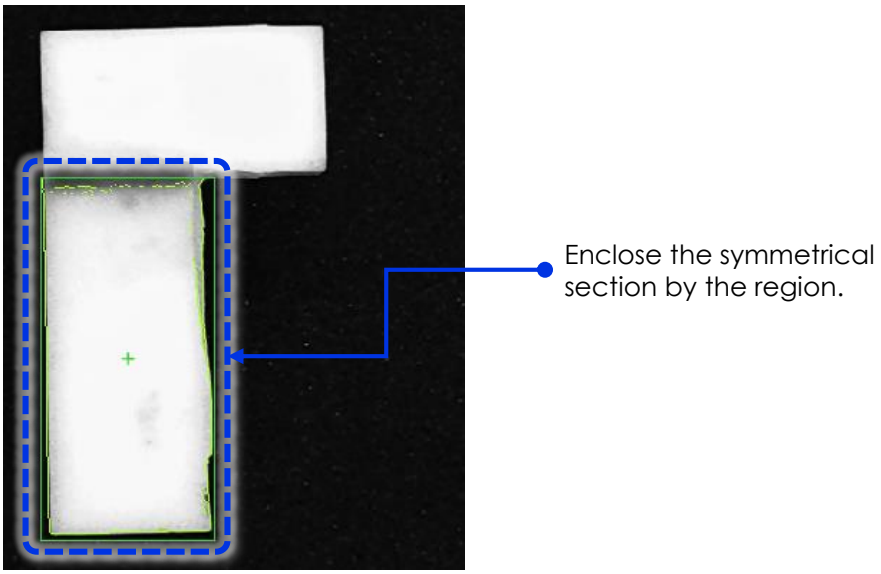
Click the [Register] button.
If the message [Overwrite the image?] appears, click [OK].

Click [OK] to close.
Then click [OK] to close capture unit.

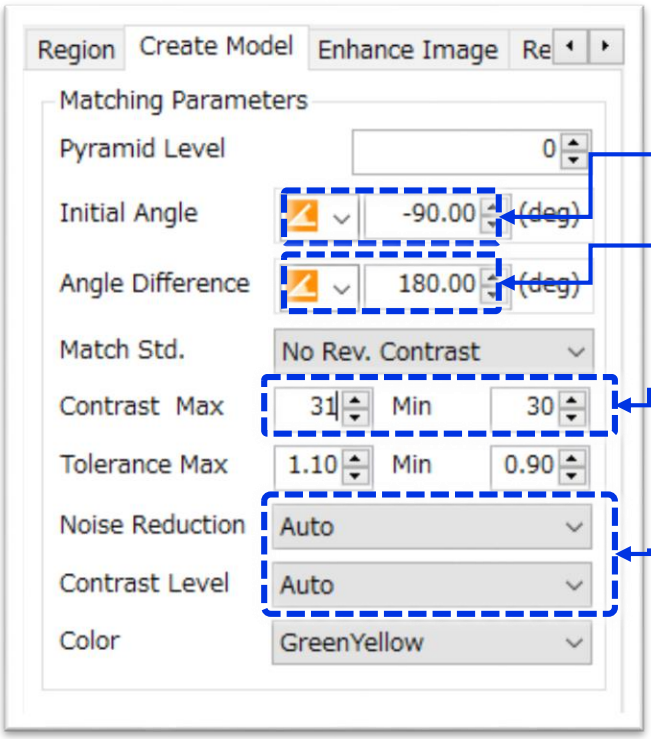
5 Register the model.
Click [Conf. Models]
Change model name and [Edit].



6 Open [Region] tab, click [Edit] button and draw the region by mouse left button, fix the region by mouse right click.
Enclose the symmetrical portion of the workpiece to create a 180-degree model.



7 Open the [Create Model] tab, and adjust the parameters as shown below.
* The information shown below is just one example. Make adjustments as necessary for your image.



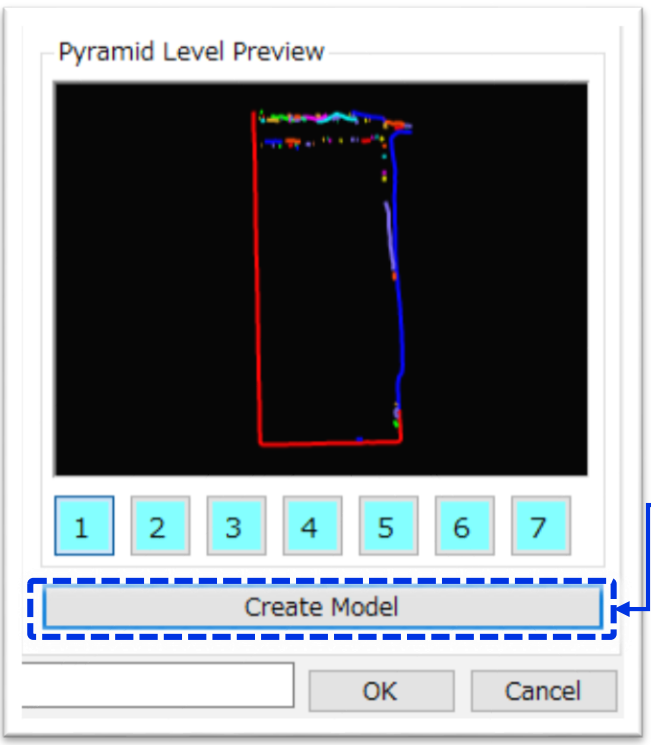
Set [Initial Angle] to "-90" deg.

Set [Angle Difference] to "180" deg.

If the green outline of the shape is not appeared well or noisy, this value should be adjusted first.

These parameter also affect the shape model.

8 Run [Create Model].

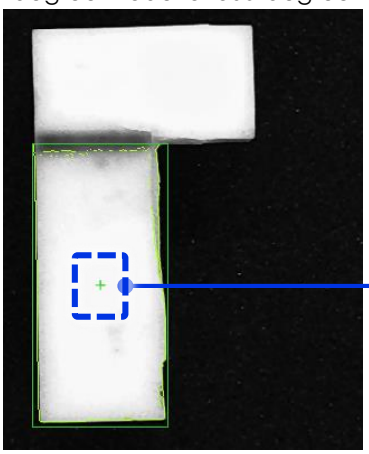


Click the [Create Model] button.

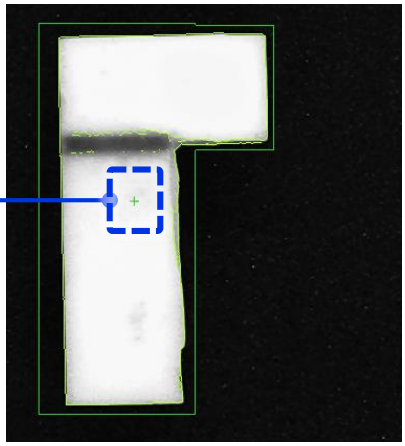
If the model is not resemble the outline of the target workpiece, adjust above parameters observing green line on the workpiece.

9 In the same way, create a 360-degree model for the entire workpiece.
Note that when you create a model for the entire workpiece, the center of the created model is actually different from the target grab position.
Therefore, it is necessary to change the center coordinates of the 360-degree model to align to the center coordinates of the symmetrical portion of the workpiece.
As a preliminary step, make a note of the center coordinates of 180-degree model created earlier.

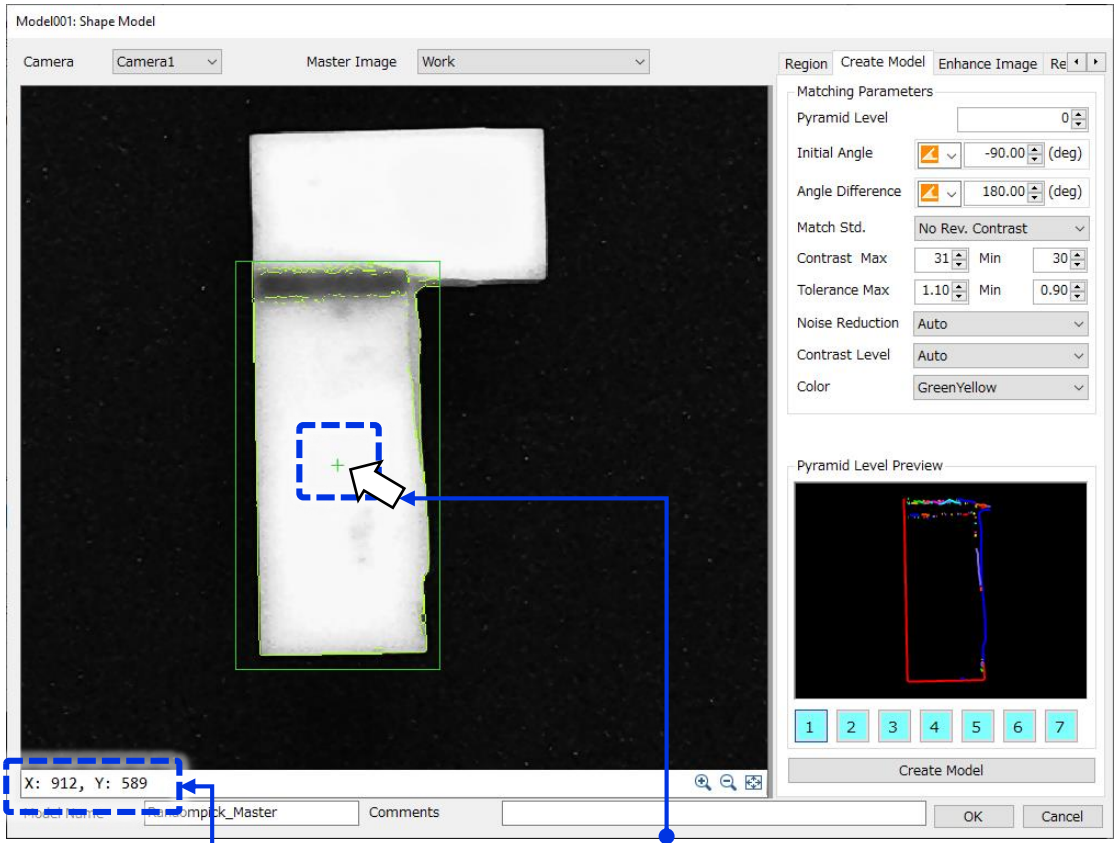
Model of the symmetrical section of the workpiece
(Target position to grab the workpiece either using 180-degree model or 360-degree model.)



Model of the entire workpiece
(The center position shifted toward the top right.)

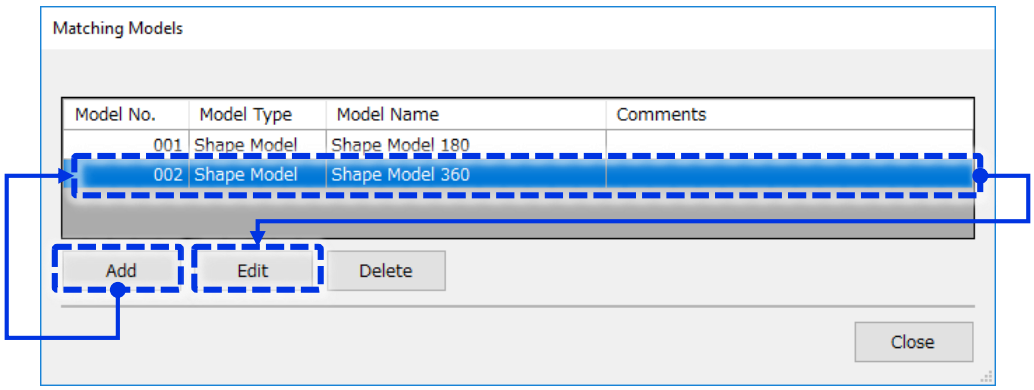


[Model of symmetrical section of the workpiece]
(Enlarged so that the green cross marking = center is easier to see.)

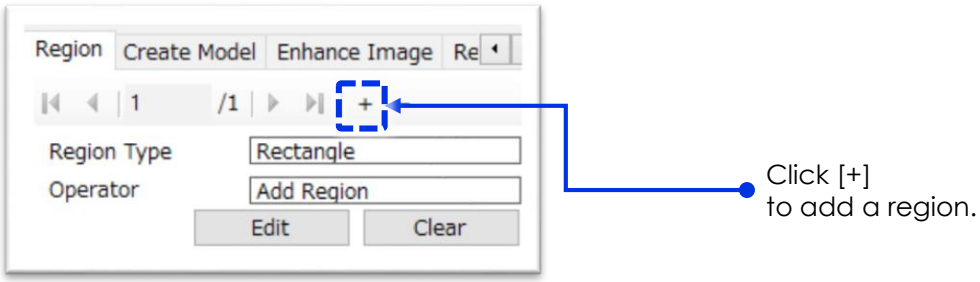


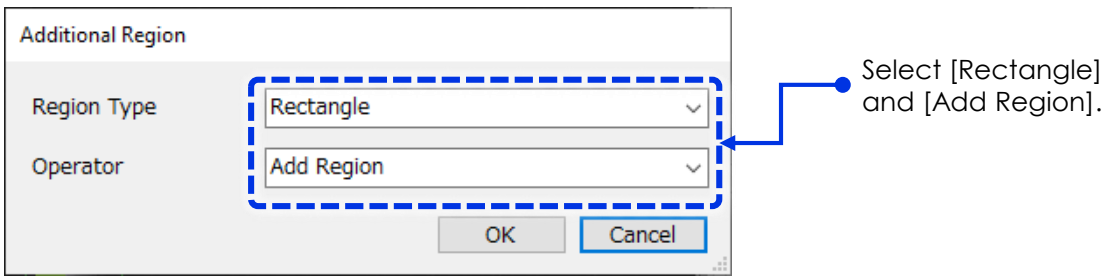
Move the mouse cursor to the center of the workpiece green cross, and make a note of the coordinates shown on the bottom left.

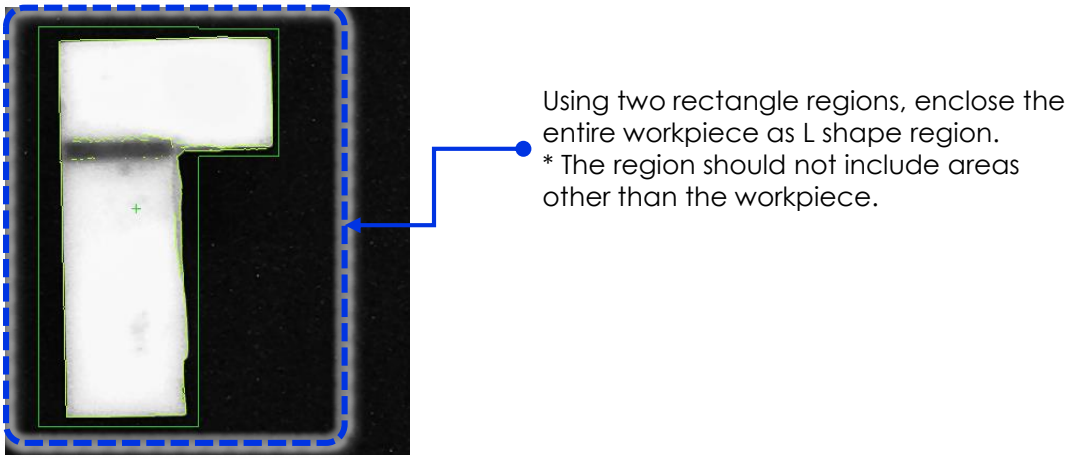
10 Create a new model by adding another Shape Model in the Matching Models window.
* Change the model name to "Shape Model 360" to distinguish between the 180-degree model and the 360-degree model.



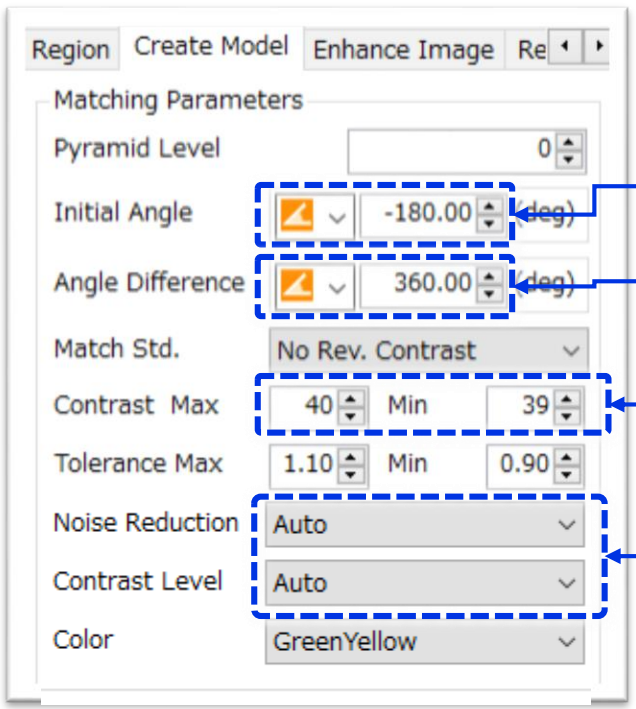
11 Select Camera [Camera1] and Master Image [Work].
Add 2nd rectangle region to cover entire L shape workpiece.







12 Set the angle of the workpiece. Crate a model and adjust parameters to get clean L shape outline.



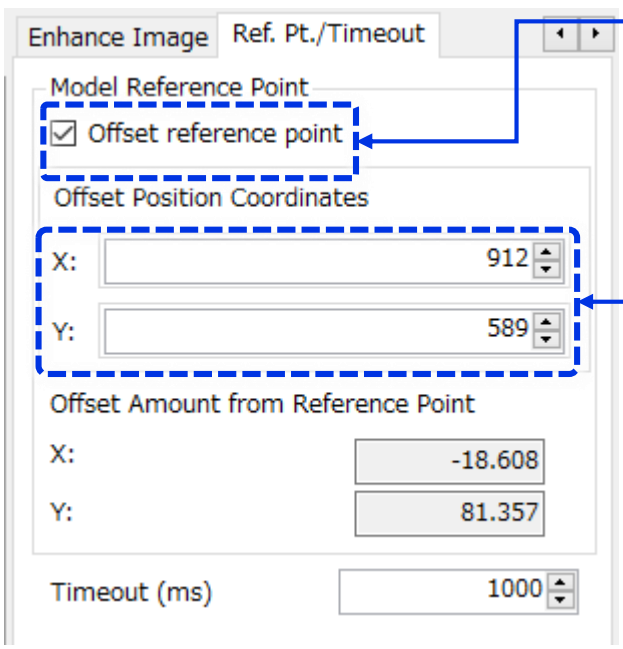
Set [Initial Angle] to "-180" deg.

Set [Angle Difference] to "360" deg.

If the green outline of the shape is not appeared well or noisy, this value should be adjusted first.

These parameter also affect the shape model.

13 Offset the center position.
Enter the coordinates taken note earlier.



Select [Offset reference point].

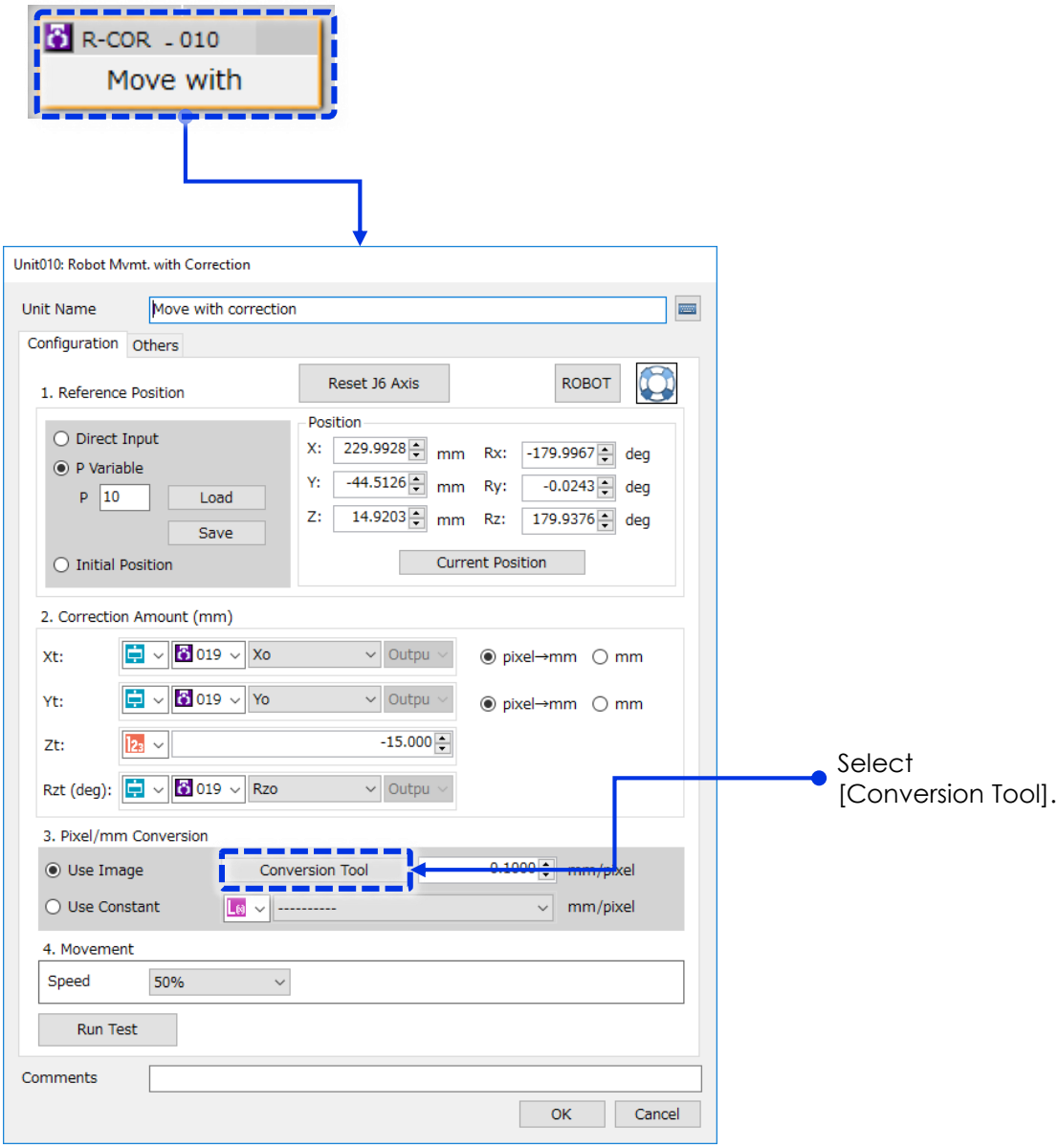
Enter the coordinates made a note earlier.

14 After offset the coordinates, make sure to open [Create Model] tab and click [Create Model] again.
Click [OK] to close.

(4) Creating a workflow for picking the workpiece

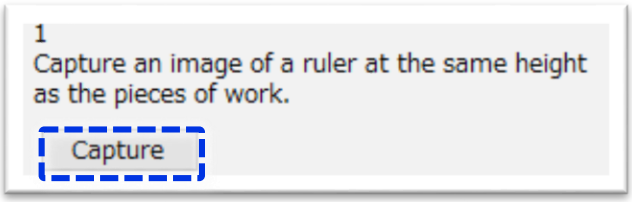
Create a workflow from capturing image until picking workpiece.
Basically, this is the same procedure as Work Support Manual "Pick & Place basic".

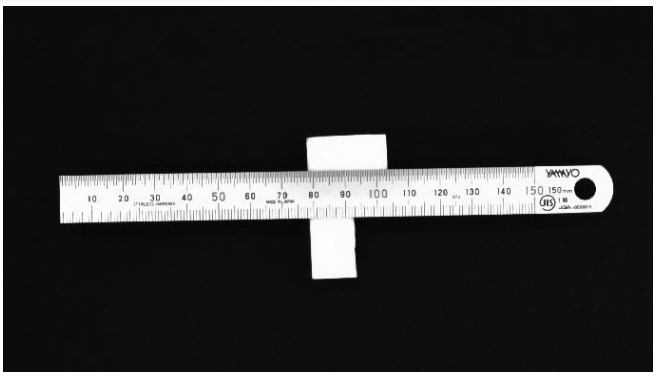
1 Configure the pixel to mm conversion settings.
Click [R-COR -010 Move with correction] unit to open.



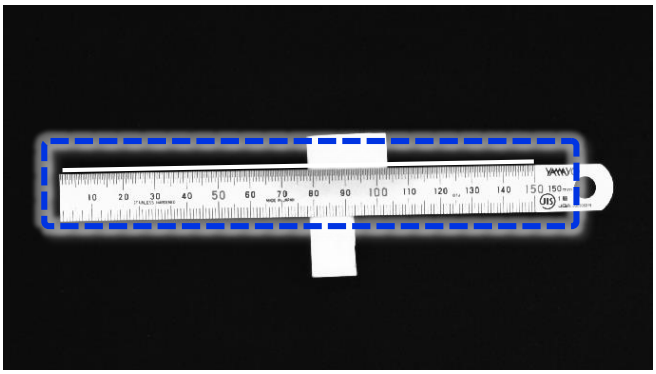
2 Robot arm should be at the image capture position.
Place the target workpiece roughly underneath the camera.

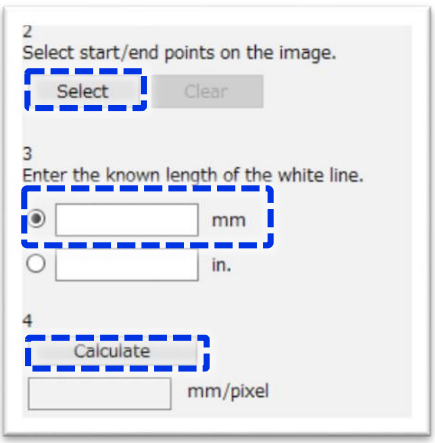
3 Place a ruler on top of the workpiece, then click [Capture] button.
* If the ruler is overexposed and the scale cannot be read, create and set up a different capture unit.



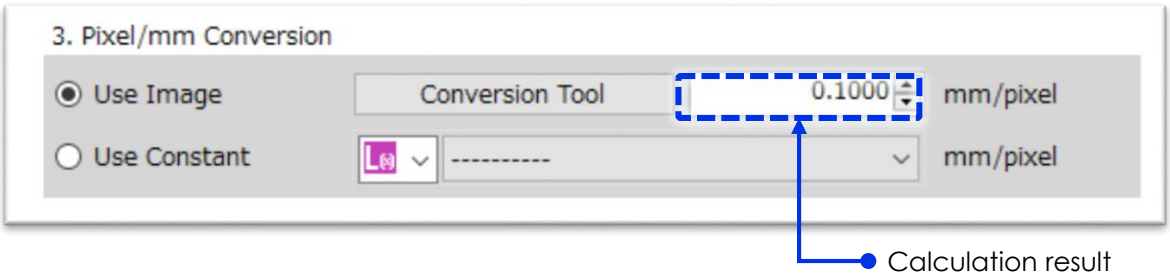


4 Click [Select] button, mouse left click to select the start point of the ruler and drag the line to the end point, release left button and right click to fix.
Read the length on the ruler and enter the value to mm box.
Click [Calculate] button, then click [OK] button.

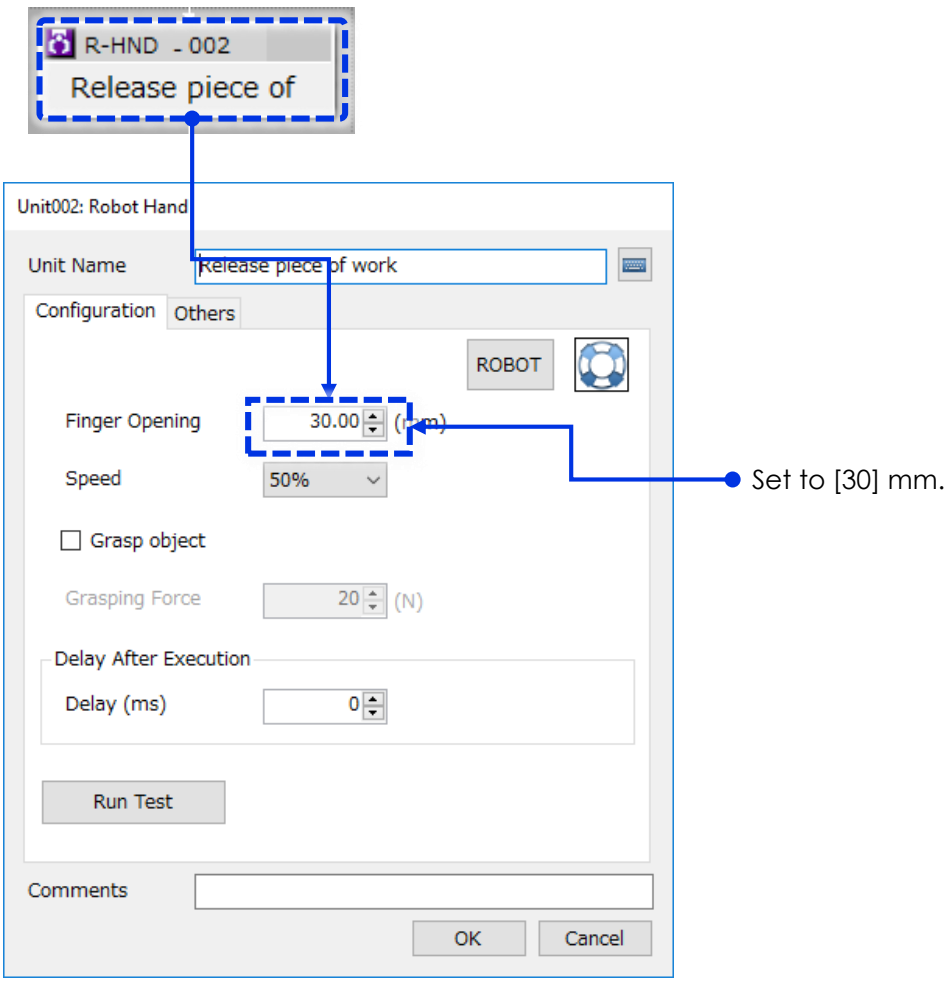




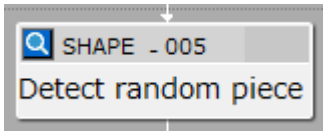
5 The calculated results should appear to the box of [Conversion Tool].
Click [OK] to close.



6 Configure the [002 Release piece of work] settings.
Enter the width larger than the workpiece is sufficient to release the workpiece, in this example set the hand to its maximum finger opening of 30 mm.

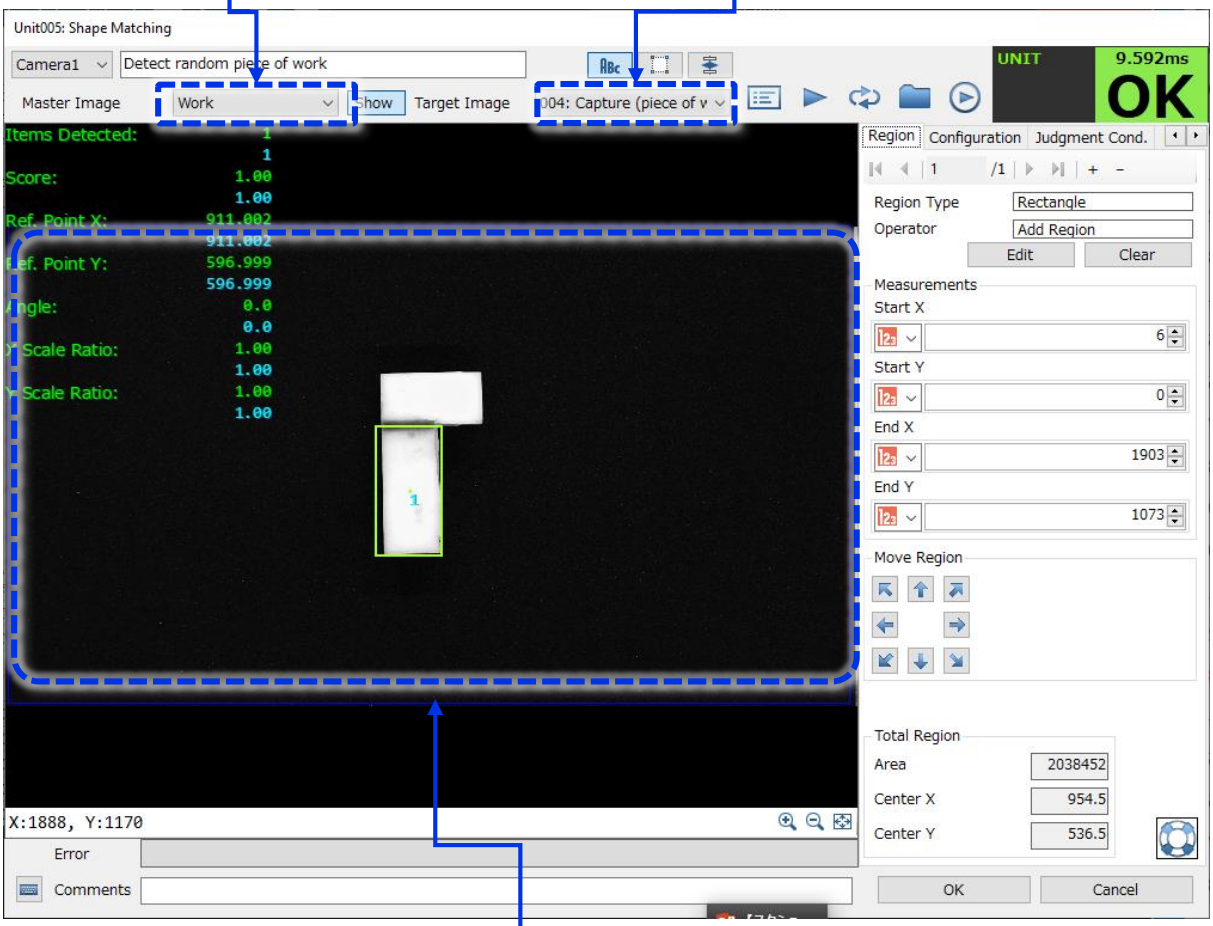


7 Configure the settings for shape matching unit [005 Detect random piece of work].



Select [Work] for master image.

Select [004: Capture]



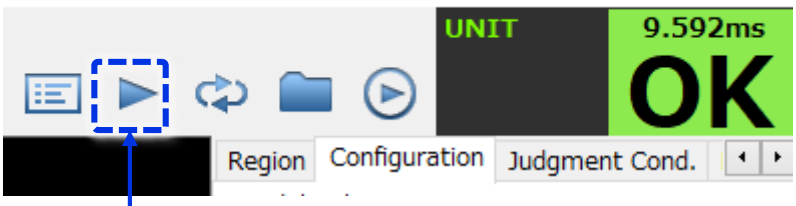
Select the entire image for the region.

8 Click [Configuration] tab, and configure the settings.

Select 180-degree model.

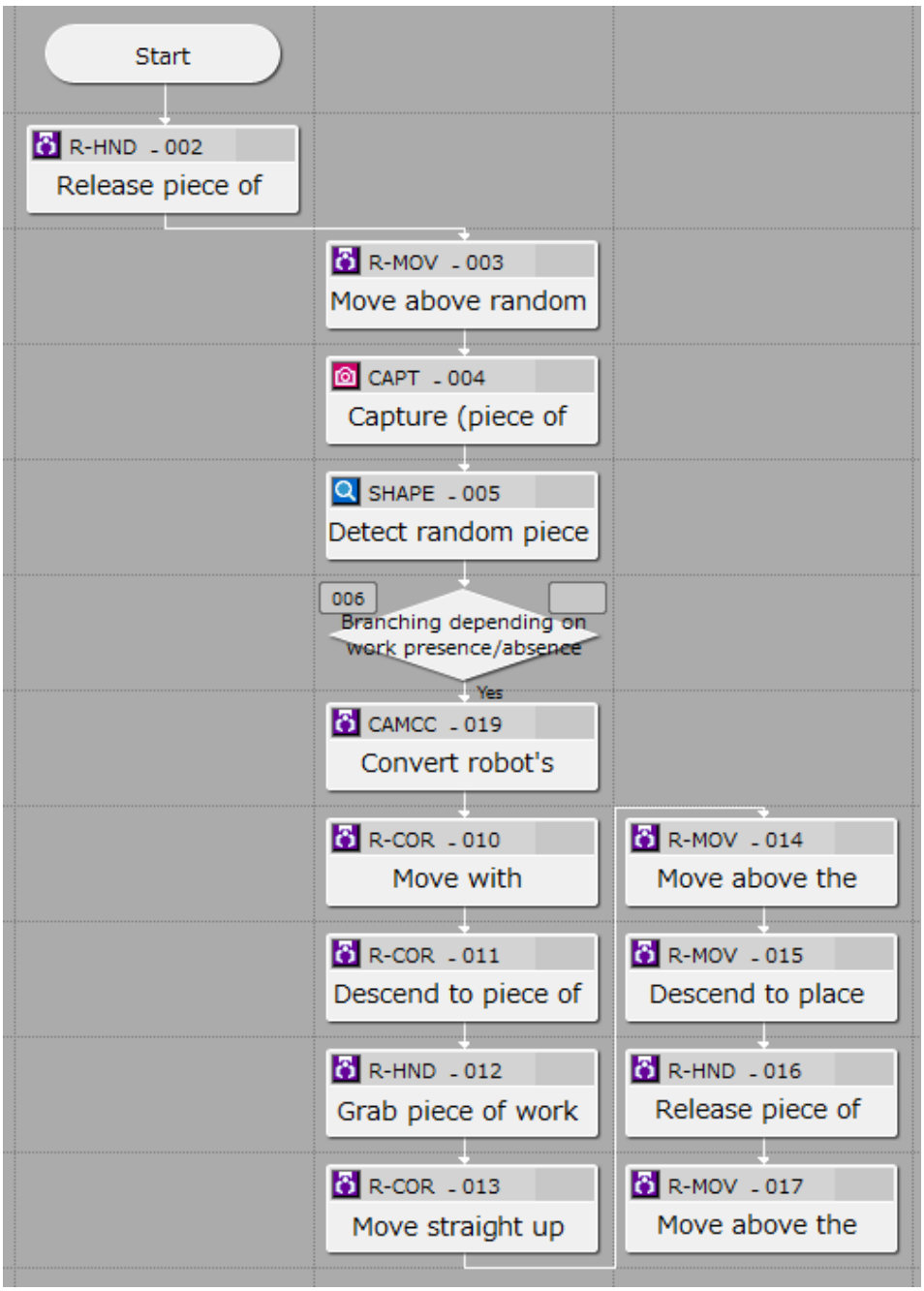
Set the maximum number of matches to "1".

9 Click the [Manual Trigger] button at the top of the screen, and check if the workpiece is recognized correctly.
Move the workpiece in a variety of angles to check for the accurate detection.



Click Manual trigger to test.
Click [OK] to close the unit.

10 At this point, the following flowchart should be completed.
* Note that the arrangement of some units has been changed, to make them easier to see.

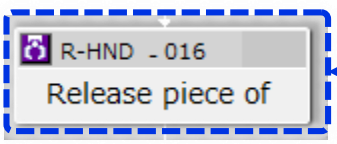


11 Break the connection between [012 Grab piece of work] and [013 Move straight up], connect [012 Grab piece of work] to [End], and check if the workflow is performed until grabbing the workpiece.
With the hand holding the workpiece, proceed to the next step.

(5) Creating a workflow for changing the orientation of the workpiece

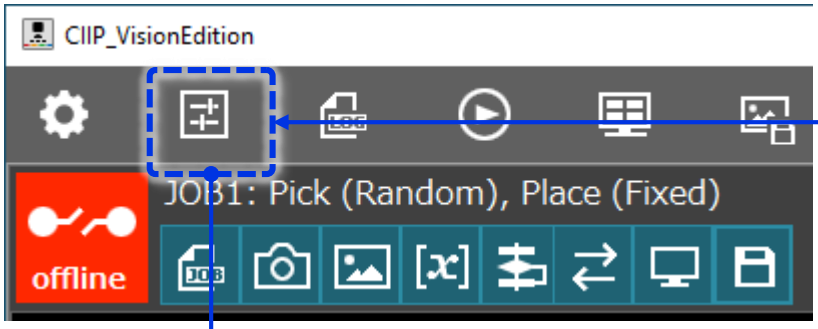
Picked workpiece is being placed at the pick reference position in either +90° or -90° rotation from the original target workpiece orientation.
Place it again in this way makes it possible to pick a workpiece with 360-degree model since J6 joint only need to rotate either +90° or -90°.

1 Since the previous step finished with the hand holding the workpiece, release the workpiece and move it outside the pick area.

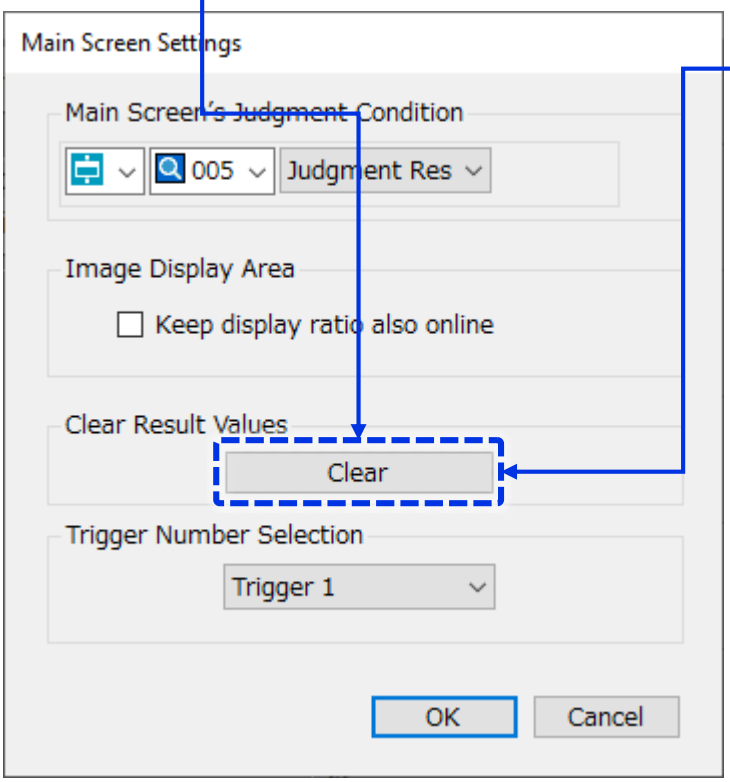


Open [002 Release piece of] or [016 Release piece of] unit and click [Run Test] to open the hand.
Take away the workpiece from robot hand.

2 If the data from the previous offline execution remains, the position will be shifted when running a test in the future.
Therefore, select [Main Screen Settings] and click [Clear].

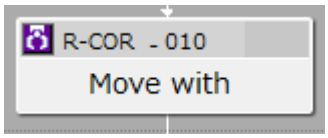


[Main Screen Settings]

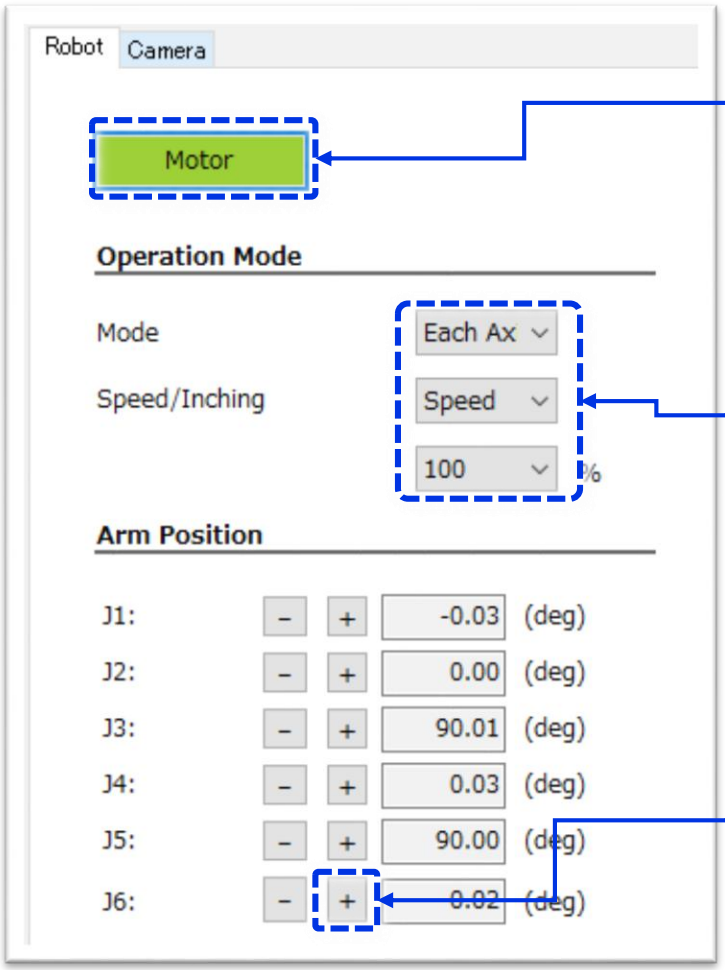


Click [Clear].

3 Next, open [010 Move with correction] unit and click [Run Test] to move the robot arm to the pick reference position which should be without any correction as pattern matching data is cleared.



4 Click [ROBOT], turn [Motor] on, and set [Mode] to [Each Ax].
Set [Speed] to [100%].
Under these conditions, click [+] for the J6 joint and increase it to 90 deg.



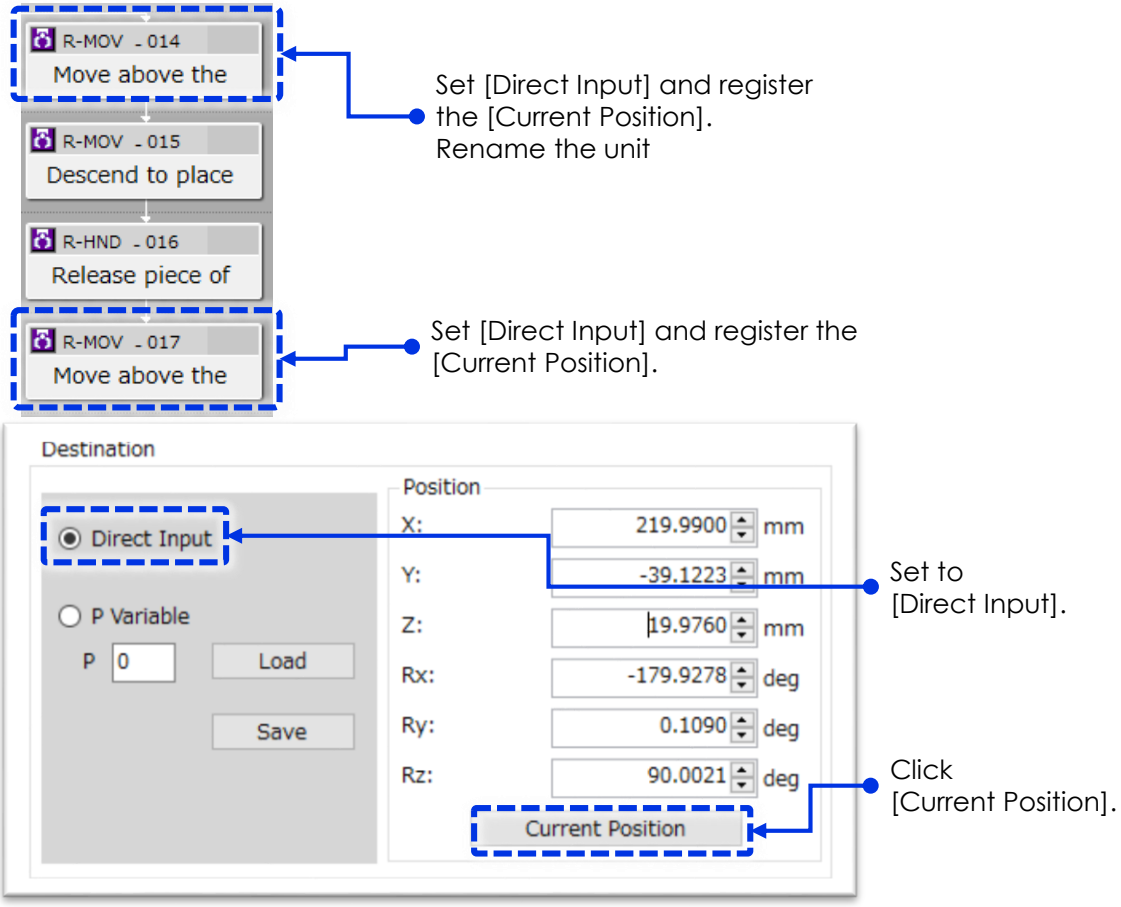
Turn [Motor] ON.

Set [Each Ax], [Speed], and [100%].

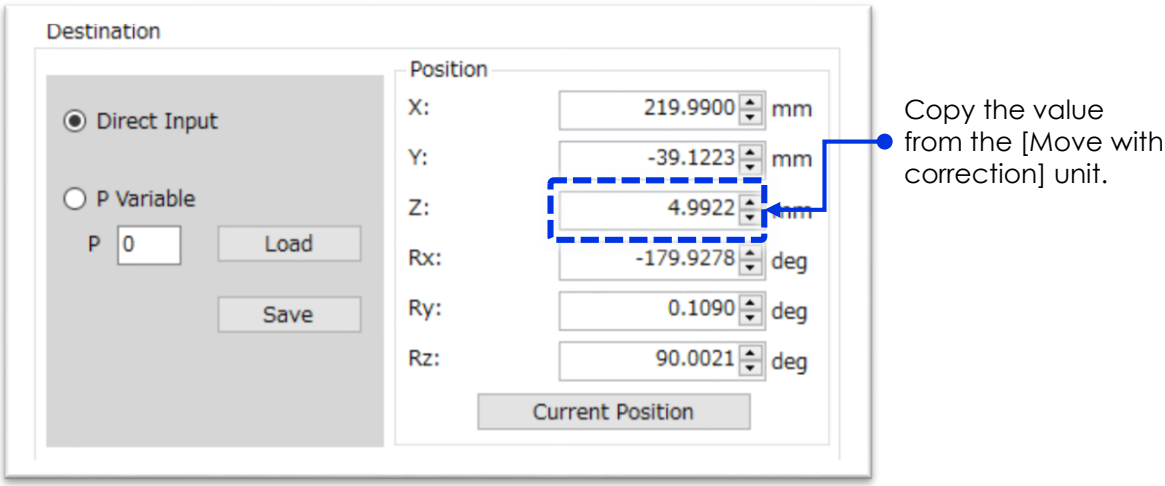
Click J6 [+] button to increase the value to 90 (deg).

Click [Close] to close the robot controlling window.
Then click [OK] to close the unit.

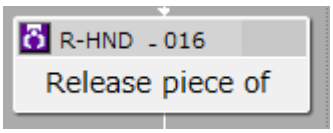
5 Open [014 Move above the place position] unit.
Set [Destination] to [Direct Input] and click [Current Position] to register the rotated pick reference position. Click [OK] to close.
To distinguish between each unit, change the name of the [014 Move above the place position] unit to [014 Rotate piece of work].
Repeat the same procedure for [017 Move above the place position] unit but no name change on this unit.



6 Open [015 Descend to place position] unit, set [Destination] to [Direct Input], and click [Current Position].
After register the current position, copy the value for Z from [010 Move with correction] unit and paste it here.
This completes the unit for placing the workpiece on the floor.



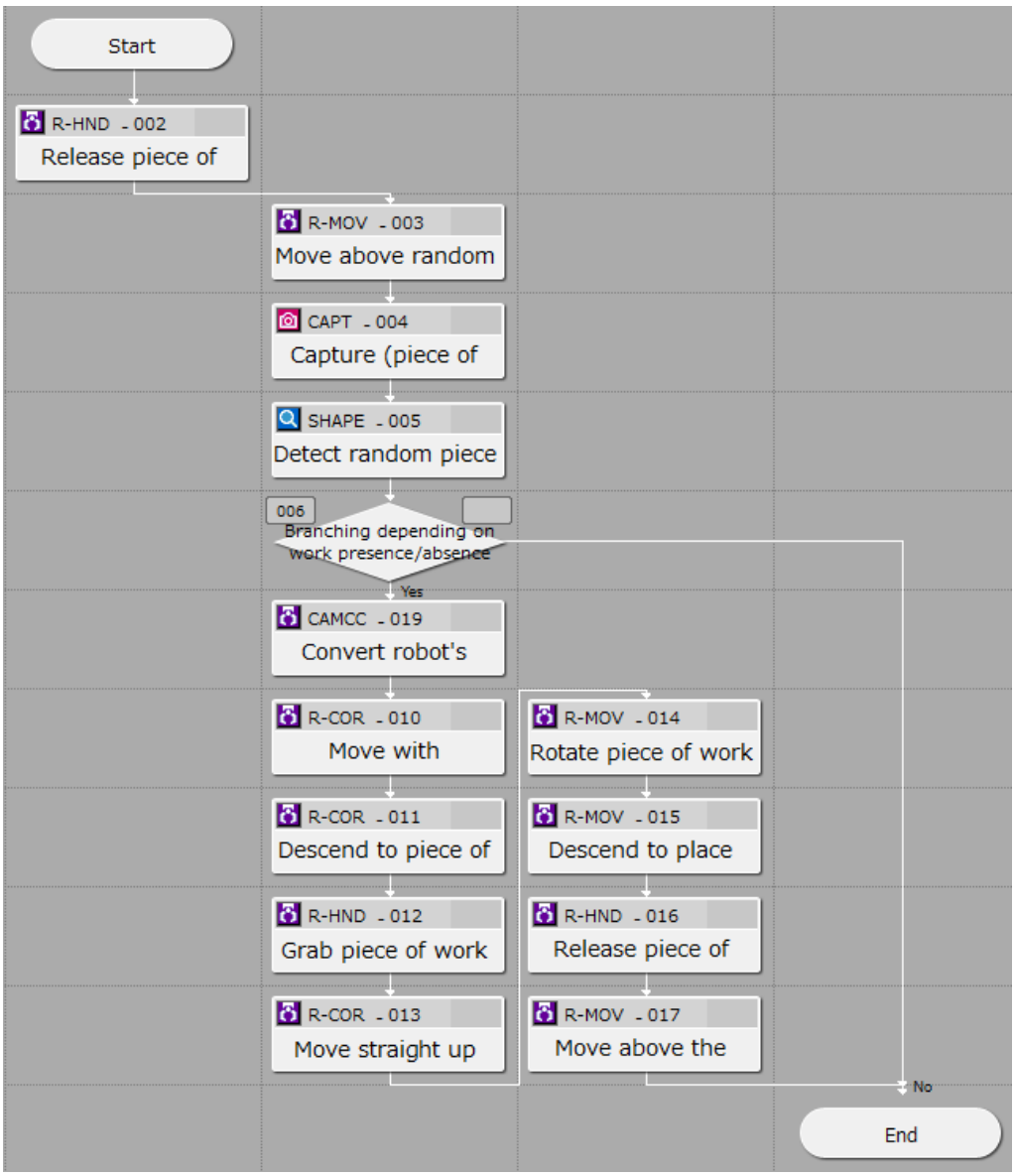
7 Configure the [016 Release piece of work] settings.
Enter the width larger than the workpiece is sufficient to release the workpiece, in this example set the hand to its maximum finger opening of 30 mm.



8 Disconnect [012 Grab piece of work] from [End] and reconnect to [013 Move straight up].
Connect [006 Branching] unit to [End] and [017 Move above the place position] to [End].

At this point, the following flowchart should be completed.
If any of the connections are broken, connect them as shown in the figure below.

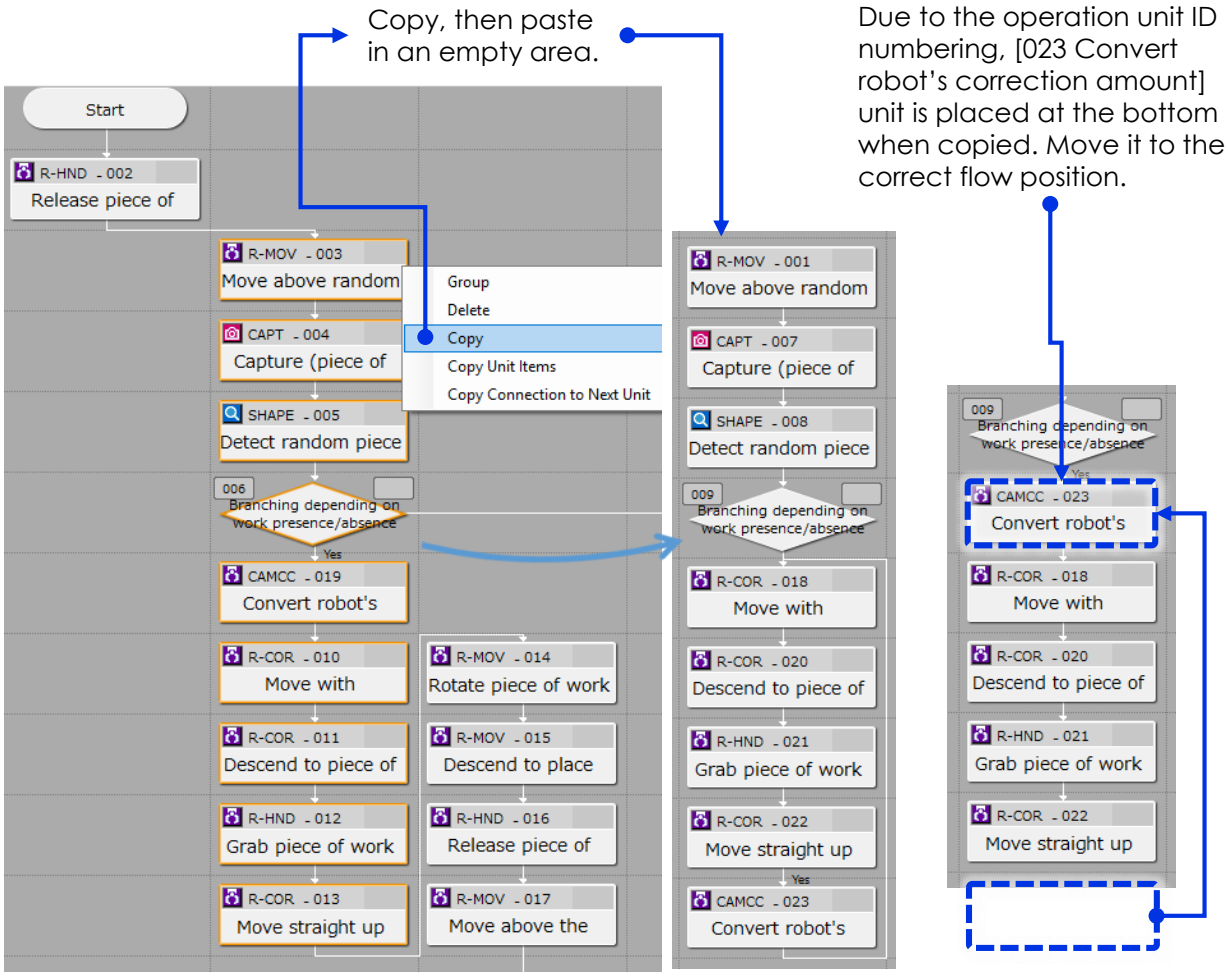
In this workflow, the robot will perform a random pick of the workpiece, lift and place back to the pick reference position but 90° rotated from original target workpiece orientation.
Run manual trigger and check if this workflow is performed correctly.



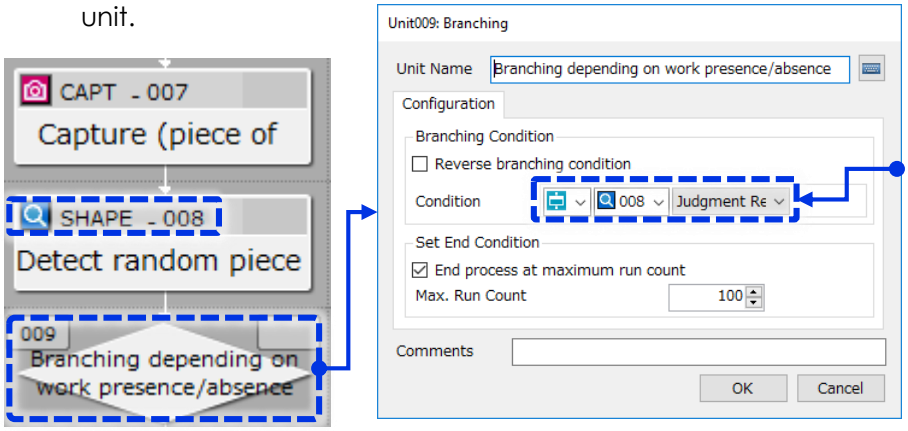
(6) Creating a pick workflow once again for the rotated workpiece

Copy and paste the workflow created in step (2) to (4), make partial changes to create a workflow for picking the workpiece with +90° or -90° angle from the pick reference position with 360-dgree model.

1 Holding mouse left key and drag the area to select below operation units. Then mouse right click to select Copy operation. (Or Mouse left click + Ctrl key to select each units and Mouse right click + Ctrl to select Copy). Paste them to an open area.



2 Click [009 Branching depending on work presence/absence] unit at the copy destination. When copied, conditions associated with the copied object are copied as is. Therefore, need to change the branching condition of the unit to the copy destination unit.



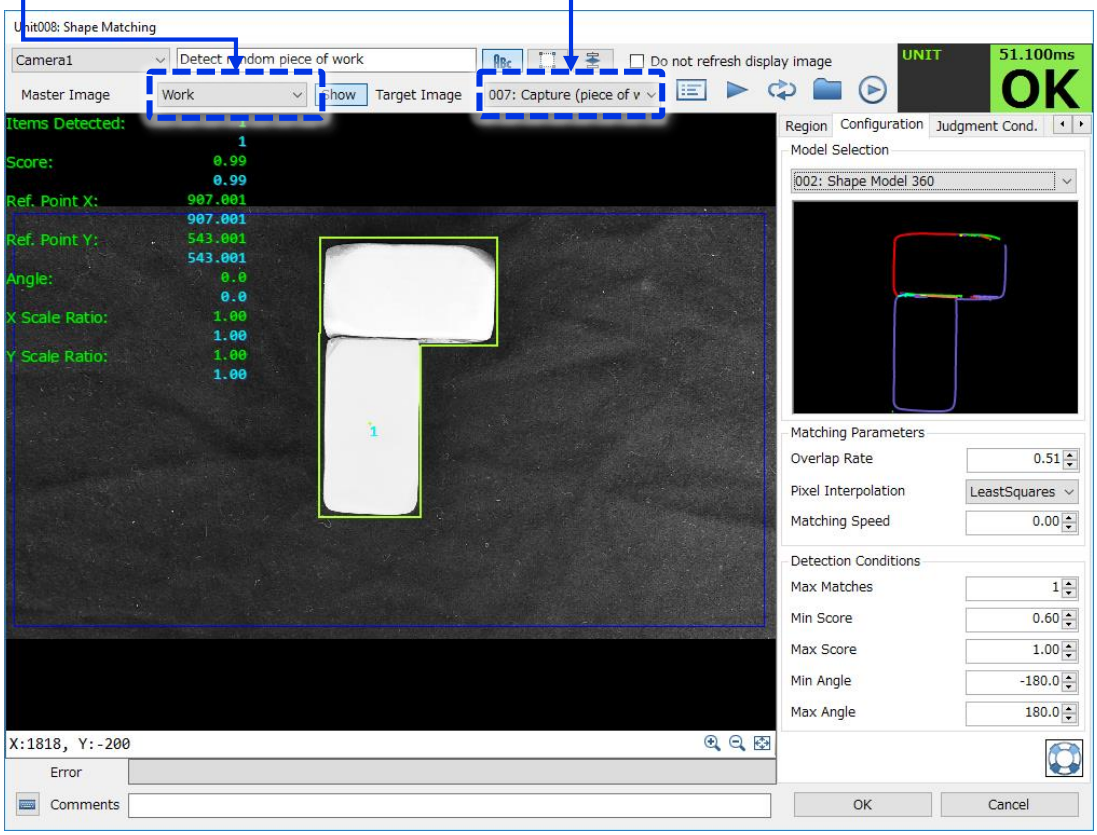
Change the unit from [005 Detect random] to [008 Detect random] and set to [Judgement Result].

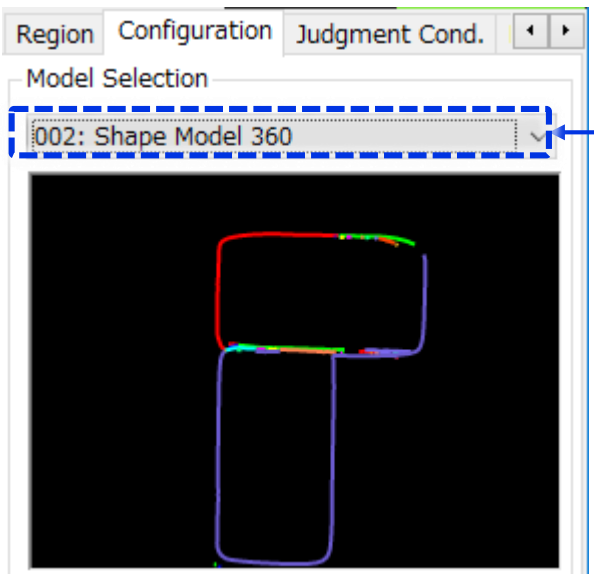
3 Connect the "No" side of [009 Branching depending on work presence/absence] at the copy destination to [End].
(The "Yes" side is already connected to another unit. Therefore, simply connecting [009 Branching depending on work presence/absence] to [End] will automatically create the connection with the “No” side.)

4 Edit [008 Detect random piece of work] at the copy destination as shown below.

Same as the master image before copying

Change to the capture unit at the copy destination.

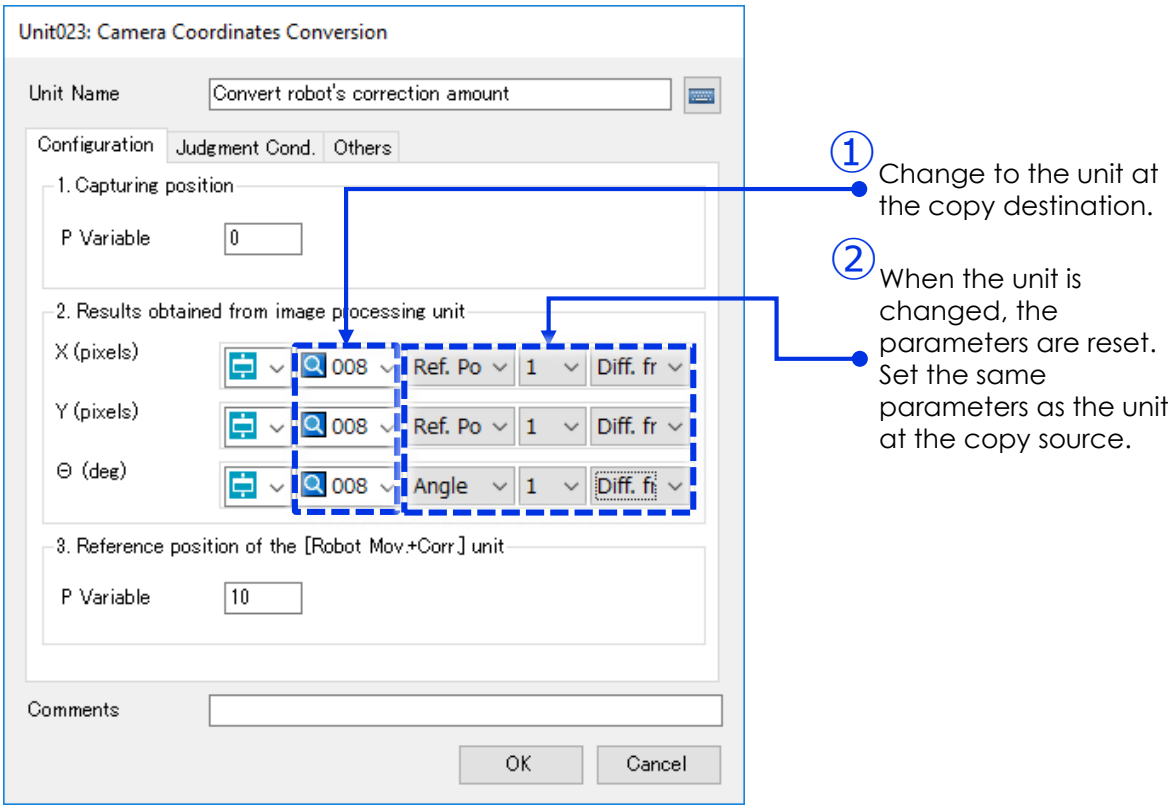




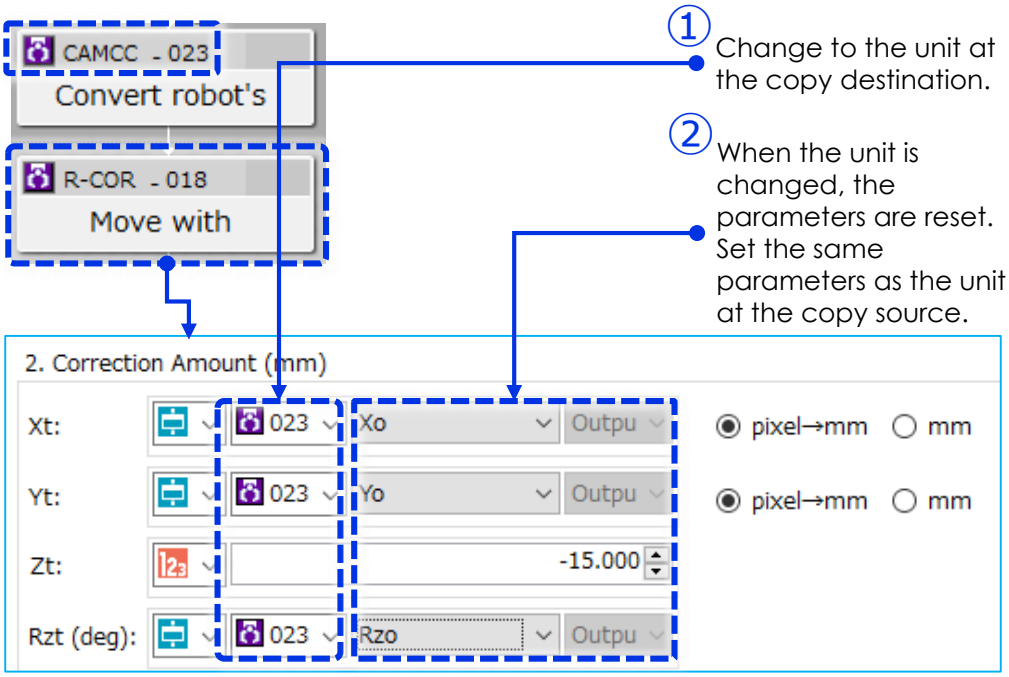
Select the 360-degree version of the shape model created in step (3).

Click [OK] to close.

5 Open [023 Convert robot's correction amount] unit at the copy destination, and change it to the shape matching unit in the workflow at the copy destination. (The default setting is the unit at the copy source.)
For parameters after the matching unit, simply copy the contents of the units from the copy source without changes.



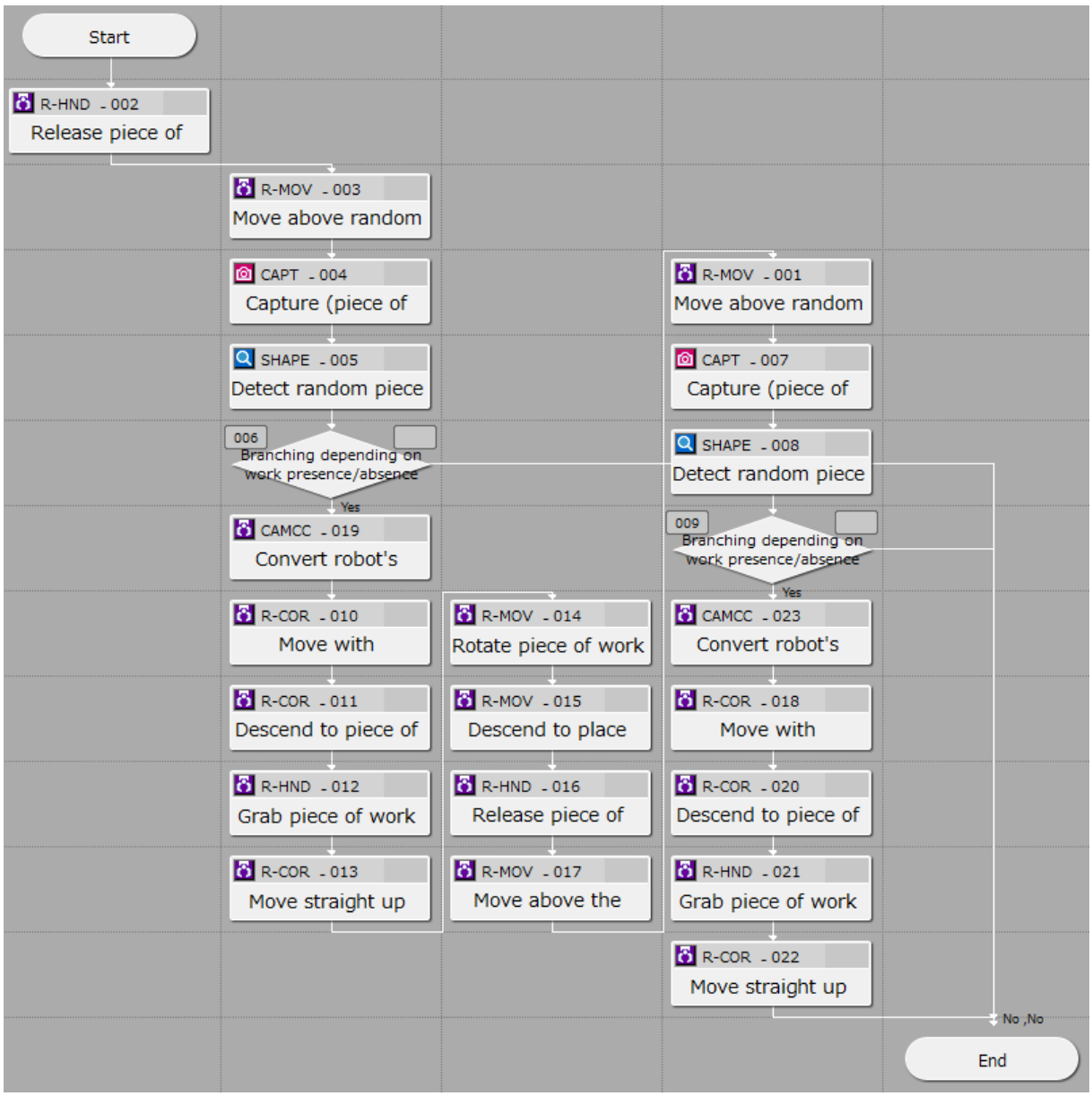
6 Open [018 Move with correction] unit at the copy destination, and change Xt, Yt, and Rzt (Deg) under [Correction Amount] to the units at the copy destination.



7 Disconnect the [017 Move above the place position] unit from [End] and connect to the [001 Move above random pic position] unit at the copy destination.
Connect the [022 Move straight up] unit at the copy destination to the [End].

If any of the connections are broken, connect them as shown in the figure below.

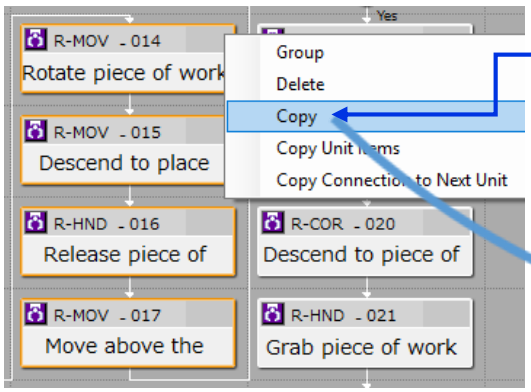
Run the workflow to check if it is performed correctly.
If it runs correctly, the robot will perform a random pick of the workpiece, lift and rotate it 90° of original pick reference position orientation, place it back in the same position (which is the workflow created in step (5)) then perform random pick using 360-degree model this time.
Open [002 Release piece of work] unit, [Run Test] to release the workpiece.



(7) Creating a workflow for the final placement of the workpiece

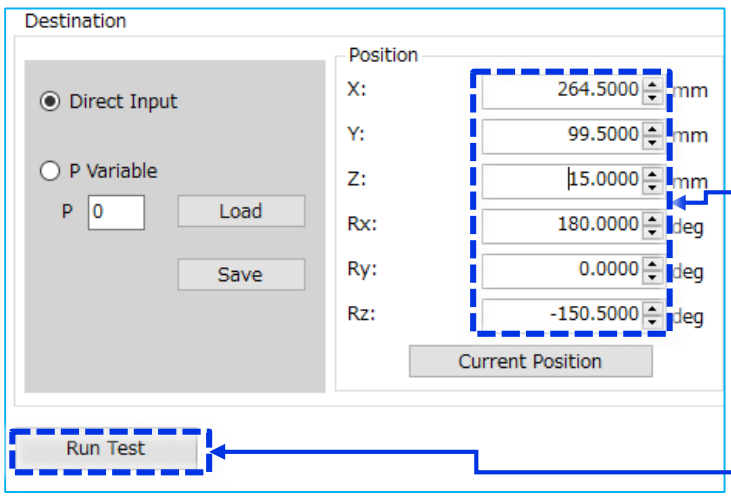
Copy and paste the workflow created in step (5), make partial changes to create a workflow for placing the workpiece in the specific orientation.

1 Use the same procedure as in step (6) to copy and paste the workflow [014 Rotate piece of work] to [017 Move above the] created in step (5) (in this workflow, the final placement position will be defined).



2 Edit [025 Descend to place position] unit. First, change the name of the unit to [025 Descend to place position 2]. Next, set the position values as shown below.

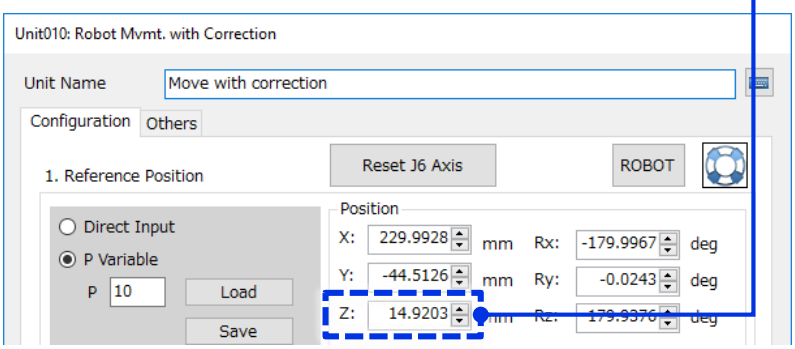
* This is merely one example of the final placement position.



Enter the following coordinates accurately in the input fields for [Position].

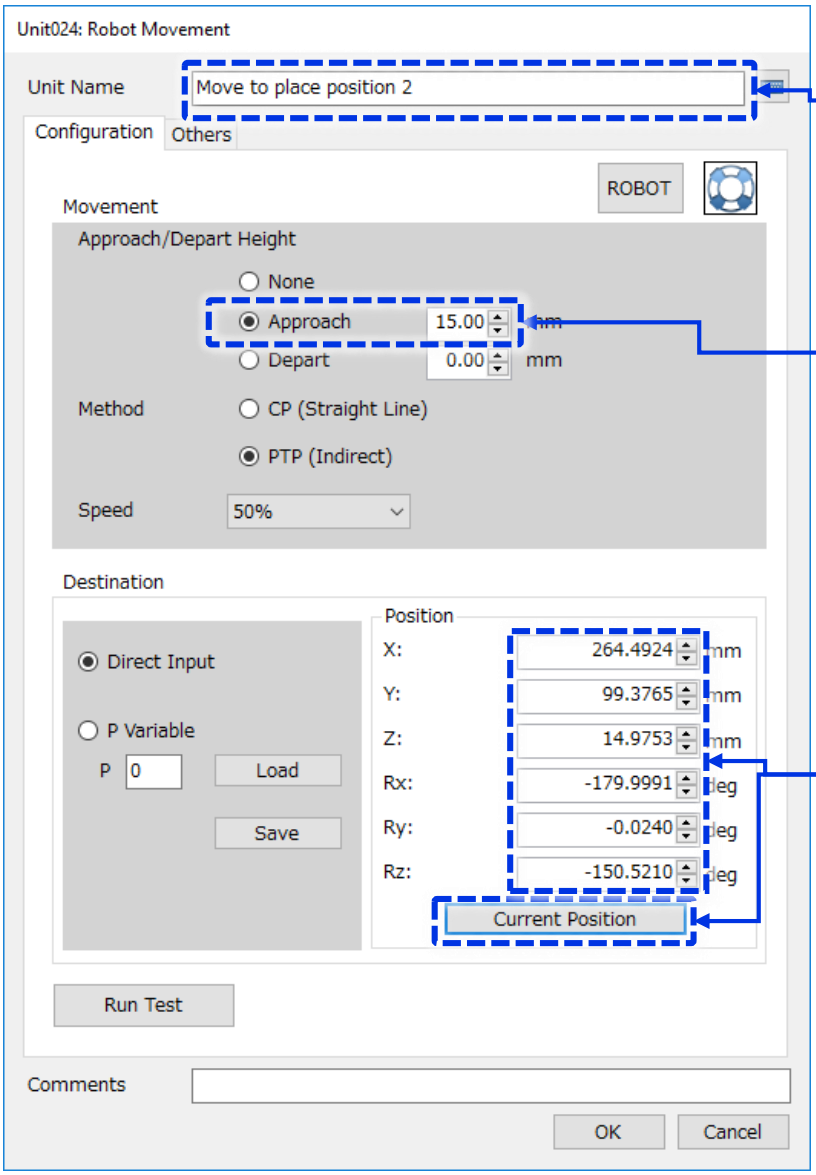
X= 264.5
Y= 99.5
Z= same as Z value of [010 Move with correction] unit
Rx= 180
Ry= 0
Rz= -150.5

Then click [Run Test] to move the robot arm to the position.



3 Edit the [024 Rotate piece of work] unit.
First, change the name of the unit to [024 Move to place position 2].
Click [Current Position] (Or directly enter the same position values as [025 Descend to place position 2] unit) and set [Approach] to "15 mm".

Make the same settings for the [027 Move above the place position] unit.
(It is not necessary to change the name for this unit.)

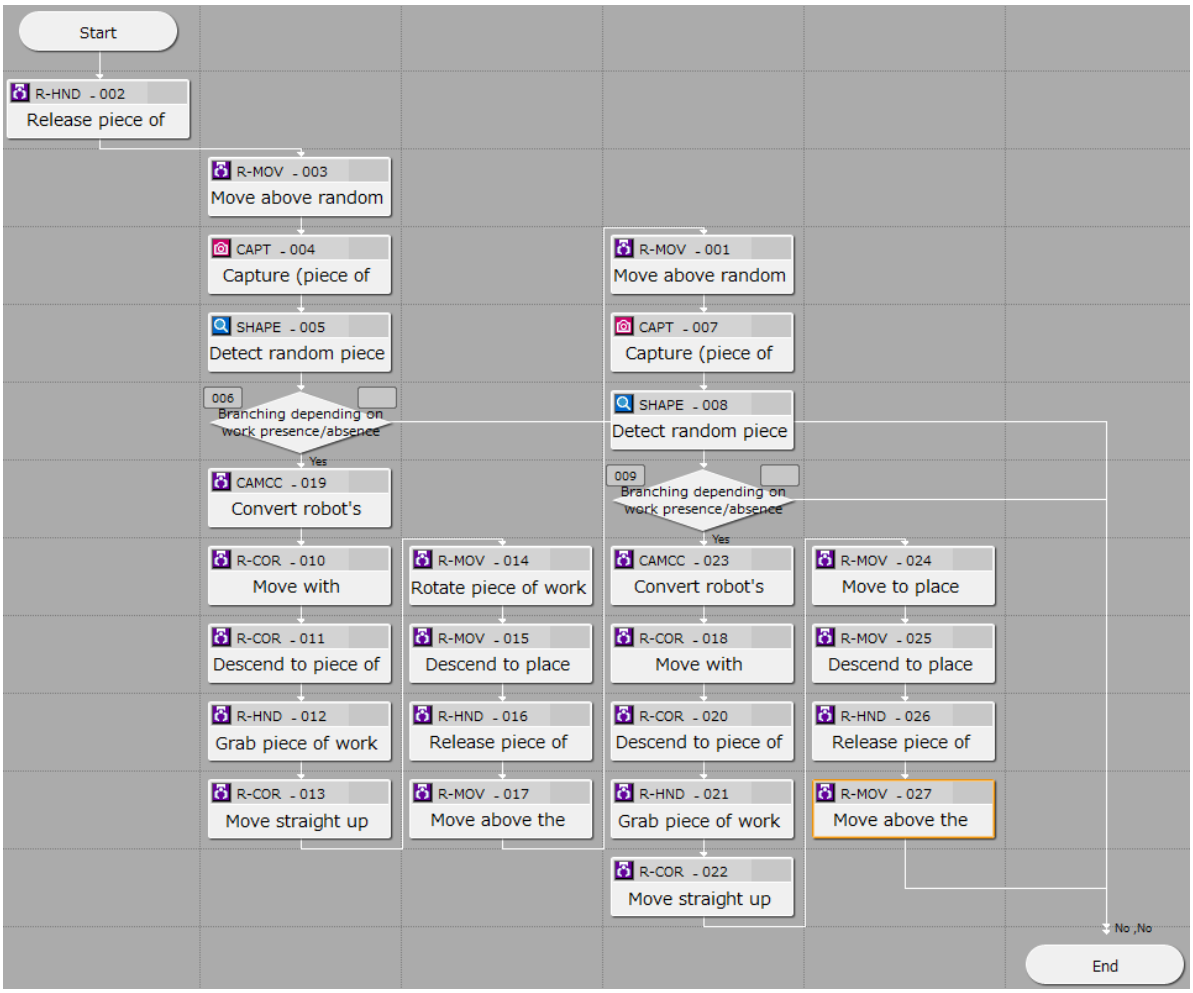


Change the operation unit name. ([024 Rotate piece of work] unit only.)

Tick [Approach] and set to 15 mm. (Both units.)

Either click [Current Position] or directly enter the same position as [025 Descend to place position 2] unit. (Both units.)

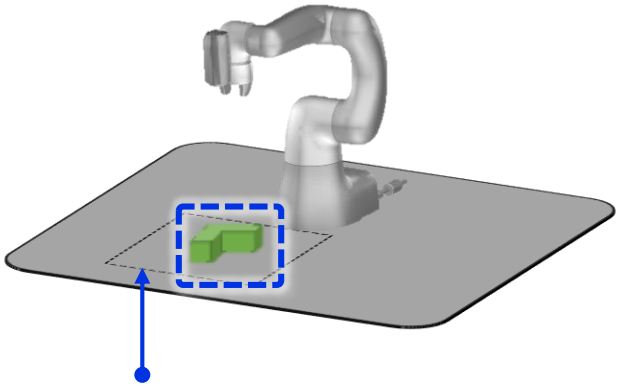
4 Disconnect [022 Move straight up] unit from the [End] and connect to [024 Move to place position 2] unit at the copy destination.
Connect [027 Move above the place position] unit at the copy destination to [End].
This completes the flowchart.



(8) Checking operation

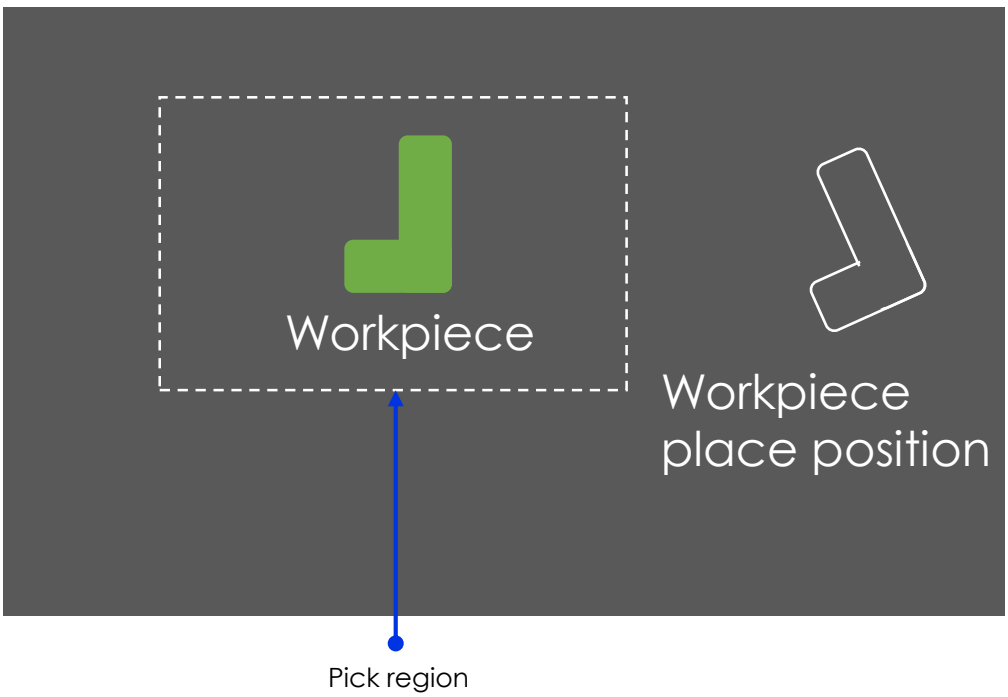
Run the entire job to pick and place the asymmetric workpiece.
Make sure that workpiece is always placed in the same specific position and direction in the end, either it placed same or opposite direction of the master image at the beginning.

1 Place the workpiece in the pick area.

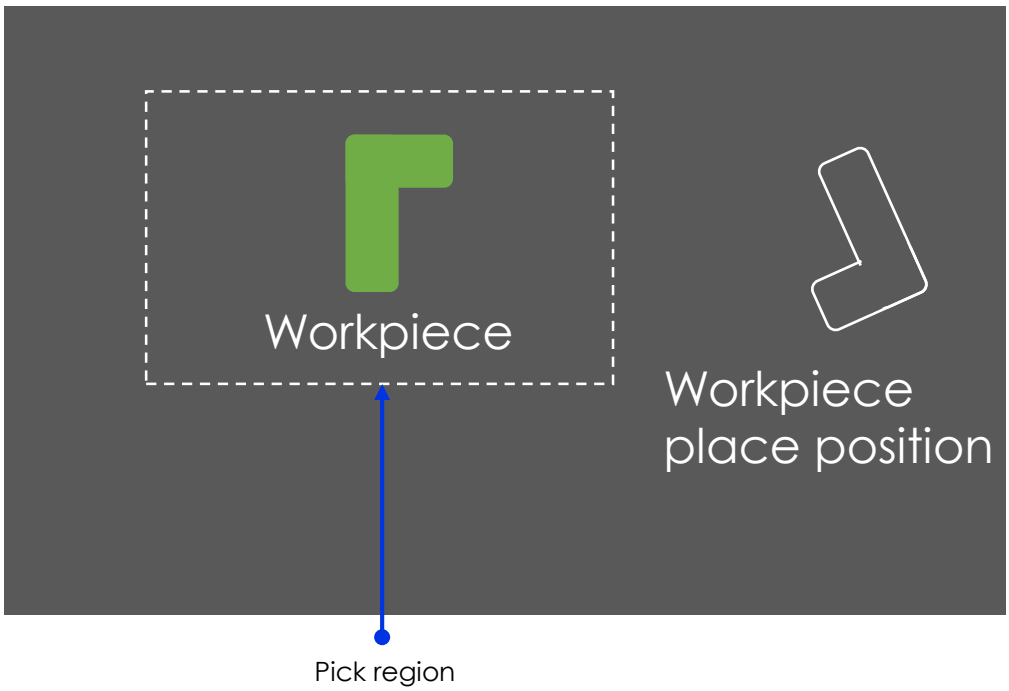


2 When testing, change the orientation of the workpiece in various patterns.
Make sure that the orientation is always the same in the final place position, regardless of how it was placed at the beginning.

Work orientation pattern (1)



Work orientation pattern (2)



Work orientation pattern (3)