FANUC Robot series

R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus/R-30*i*B Mini Plus CONTROLLER

*i*RVision 3DV Sensor

OPERATOR'S MANUAL

B-83914EN-3/04

• Original Instructions

Thank you very much for purchasing FANUC Robot.

Before using the Robot, be sure to read the "FANUC Robot series SAFETY HANDBOOK (B-80687EN)" and understand the content.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.
Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

SAFETY PRECAUTIONS

This chapter describes the precautions which must be followed to enable the safe use of the robot. Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
For safe use of FANUC robots, you must read and follow the instructions in the “FANUC Robot series SAFETY HANDBOOK (**B-80687EN)**”.

1 PERSONNEL

Personnel can be classified as follows.

Operator:
- Turns the robot controller power ON/OFF
- Starts the robot program from operator panel

Programmer or Teaching operator:
- Operates the robot
- Teaches the robot inside the safeguarded space

Maintenance technician:
- Operates the robot
- Teaches the robot inside the safeguarded space
- Performs maintenance (repair, adjustment, replacement)

- The operator is not allowed to work in the safeguarded space.
- The programmer or teaching operator and maintenance technician are allowed to work in the safeguarded space. Work carried out in the safeguarded space include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safeguarded space, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safeguarded space. In this table, the symbol “○” means the work allowed to be carried out by the specified personnel.

Table 1 (a) List of work outside the Safeguarded Space

	Operator	Programmer or Teaching operator	Maintenance technician
Turn power ON/OFF to Robot controller	○	○	○
Select operating mode (AUTO/T1/T2)		○	○
Select remote/local mode		○	○
Select robot program with teach pendant		○	○
Select robot program with external device		○	○
Start robot program with operator’s panel	○	○	○
Start robot program with teach pendant		○	○
Reset alarm with operator’s panel		○	○
Reset alarm with teach pendant		○	○
Set data on teach pendant		○	○
Teaching with teach pendant		○	○
Emergency stop with operator’s panel	○	○	○
Emergency stop with teach pendant	○	○	○
Operator’s panel maintenance			○
Teach pendant maintenance			○

During robot operation, programming and maintenance, the operator, programmer, teaching operator and maintenance technician take care of their safety using at least the following safety protectors:

- Use clothes, uniform, overall adequate for the work
- Safety shoes
- Helmet

2 DEFINITION OF SAFETY NOTATIONS

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Supplementary information is indicated by "**NOTE**". Read the contents of each **"WARNING**", "**CAUTION**" and "**NOTE**" before using the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

PREFACE

This chapter describes an overview of this manual. It should be read before operating the *i*RVision.

1 OVERVIEW OF THE MANUAL

This is a manual for the R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus/R-30*i*B Mini Plus CONTROLLER *i*RVision.
This manual describes how to operate sensor functions and create programs after completing the installation and setup of your robot. For details on basic robot operations, refer to the "OPERATOR'S MANUAL (Basic Operation) B-83284EN."
This manual is directed at users who have taken the "*i*RVision 2D Vision Sensor course" at FANUC Academy. For details on each setup item, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

> ⚠ **CAUTION**
> This manual is based on R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus/R-30*i*B Mini Plus system software version 7DF5/17. Note that depending on the software version of your robot controller, some functions or setup items described in this manual may not exist, some functions or setup items not described in this manual may exist, and some notations may be different.

Series	Chapter	Chapter title	Main content
Introduction	Chapter 1	ABOUT *i*RVision	This chapter describes the fundamental items of the vision system such as types of camera mounting methods, types of offset modes, etc.
Setup	Chapter 1	FEATURES	This chapter describes a summary of three types of applications using the 3DV Sensor.
	Chapter 2	3D FIXED FRAME OFFSET SYSTEM	This chapter describes startup procedures of the 3D fixed frame offset system.
	Chapter 3	3D TOOL OFFSET SYSTEM	This chapter describes startup procedures of the 3D tool offset system.
	Chapter 4	BIN PICKING SYSTEM	This chapter describes startup procedures of the Bin picking system.
Know-How	Chapter 1	FRAME SETTING	This chapter describes frame setting using the touch-up pointer, and the frame setting method using the calibration grid frame setting function.
	Chapter 2	3DV SENSOR DATA SETTING	This chapter describes the data setting method of the 3DV Sensor.
	Chapter 3	EXAMPLE OF SETTING ACCORDING TO USAGE	This chapter describes examples of setting according to usage for the 3DV Sensor.
	Chapter 4	TROUBLESHOOTING	This chapter describes how to troubleshoot if any failure happens while using the 3DV Sensor.

Symbol Used in This Manual

The following symbol is used in this manual. Use this symbol to find important information.

Symbol	Description
Memo	Describes information that provides help for operating screens, explains a function, or gives information for reference.

Explanation of Teach Pendant Operation

This manual explains each procedure on the assumption that teaching is performed using a teaching PC. However, some procedures include a description of operation of the teach pendant. The teach pendant can be operated through touch panel operation, but the procedures using key input, for which the operations are more complex, are described in this manual.

Simple Mode and Advanced Mode

*i*RVision provides a simple mode in which setup items with low frequency of use are hidden and an advanced mode in which all setup items are shown. This manual describes the screens and operations in the simple mode unless otherwise noted. For details on the Simple Mode and Advanced Mode, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2 RELATED MANUALS

This section introduces other manuals that you can refer to when using the functions of *i*RVision.

Manual	Spec. No.	Description
OPERATOR'S MANUAL (Basic Operation)	B-83284EN	This is the main manual. • Setting the system for manipulating workpieces • Operating the robot • Creating and changing a program • Executing a program • Status indications • Backup and restore robot programs. This manual is used for application design, robot installation, and robot teaching.
MAINTENANCE MANUAL	B-83195EN	This manual describes the maintenance and connection of the R-30*i*B/R-30*i*B Plus Controller.
MAINTENANCE MANUAL	B-83525EN	This manual describes the maintenance and connection of the R-30*i*B Mate/R-30*i*B Mate Plus Controller.
MAINTENANCE MANUAL	B-83555EN	This manual describes the maintenance and connection of R-30iB Mate/R-30iB Mate Plus Controller (Open Air Type).
MAINTENANCE MANUAL	B-84035EN	This manual describes the maintenance and connection of the R-30*i*B Compact Plus Controller.
MAINTENANCE MANUAL	B-84175EN	This manual describes the maintenance and connection of the R-30*i*B Mini Plus Controller.
OPERATOR'S MANUAL (Alarm Code List)	B-83284EN-1	This is the alarm code list for the controller. This manual describes the causes of alarm occurrence and the measures to be taken.
Optional Function OPERATOR'S MANUAL	B-83284EN-2	This manual describes the software options for the robot controller.
Sensor Mechanical/Control unit OPERATOR'S MANUAL	B-83984EN	This manual describes the method for connecting the controller and sensors such as a camera or 3D Laser Vision Sensor used for *i*RVision and the sensor maintenance method.
*i*RVision OPERATOR'S MANUAL (Reference)	B-83914EN	This manual is the reference manual for *i*RVision. • This manual describes each function provided by *i*RVision. • When you would like to know the meanings (i.e., items on the *i*RVision setup screen, the arguments of an instruction, and so on), refer to this manual.

Manual	Spec. No.	Description
*i*RVision 2D Vision Application OPERATOR'S MANUAL	B-83914EN-2	This manual should be referenced first when starting up robot systems that perform a 2D offset or a 2.5D offset using *i*RVision. • This manual describes system startup procedures, program creation methods, cautions, technical know-how, responses to various cases, etc. when performing a 2D offset or a 2.5D offset using *i*RVision.
*i*RVision Bin Picking Application OPERATOR'S MANUAL	B-83914EN-6	This manual should be referenced first when starting up a robot system that performs bin picking using the *i*RVision. • This manual describes system startup procedures, program creation methods, cautions, technical know-how, responses to various cases, etc. when performing bin picking using *i*RVision.
*i*RPickTool OPERATOR'S MANUAL	B-83924EN	This manual should be referenced first when starting up a robot system that performs visual tracking using *i*RVision. • This manual describes system startup procedures, program creation methods, cautions, technical know-how, responses to various cases, etc. when performing visual tracking using *i*RVision.
Ethernet Function Operator's Manual	B-82974EN	This manual describes the network options for the robot controller, such as FTP, RIPE, and PC share.
Tablet UI OPERATOR'S MANUAL	B-84274EN	Connection method of a tablet TP and how to teach a robot and iRVision with a tablet TP.

TABLE OF CONTENTS

Know-How

Introduction

1 ABOUT *i*RVision

This chapter explains offsetting the robot motion using *i*RVision (integral Robot Vision). *i*RVision is an image processing function integrated in a robot controller. It finds parts in an image snapped from a camera, offsets the robot motion and measures the features of the part. This chapter explains offsetting the robot motion using *i*RVision (integral Robot Vision).

1.1 *i*RVision

FANUC robots are teaching-playback robots. In a teaching-playback system, specific tasks are taught to robots in advance, which then work exactly as they are taught. A series of instructions that specify what robots are to do is called a robot program. The process of generating robot programs is called 'teaching.' And the act of executing the taught robot programs is called 'playback.' Teaching-playback robots play back the motion just as it was taught. Conversely speaking, what this type of robot can do is limited to what it is taught in advance. This means that, if you want the robot to manipulate every part in the same way, you need to place every part in exactly the same position. *i*RVision is a visual sensor system designed to eliminate such restrictions. *i*RVision measures the position of each part by using cameras, and it adjusts the robot motion so that the robot can manipulate the part in the same way as programmed even if the position of the part is different from the part position set when the robot program was taught.

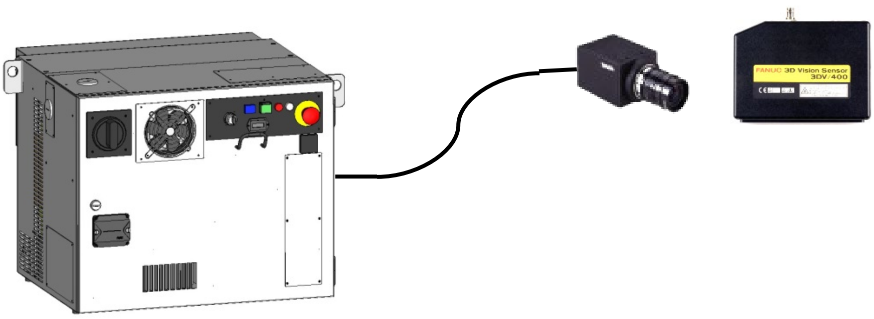
*i*RVision is the vision function integrated into the FANUC robot controller. *i*RVision incorporates a 2D Camera that performs a 2D offset and a 3DV Sensor, 3D Area Sensor and 3D Laser Vision Sensor that perform a 3D offset.

1.2 BASIC CONFIGURATION

*i*RVision consists of the following components:

2D Camera system
- Robot controller
- Camera & lens
- Camera cable
- Camera multiplexer (used if needed)
- Lighting equipment

3DV Sensor system
- Robot controller
- 3DV Sensor
- Camera cable
- Camera multiplexer (used if needed)
- Lighting equipment (used if needed)



Basic configuration of *i*RVision

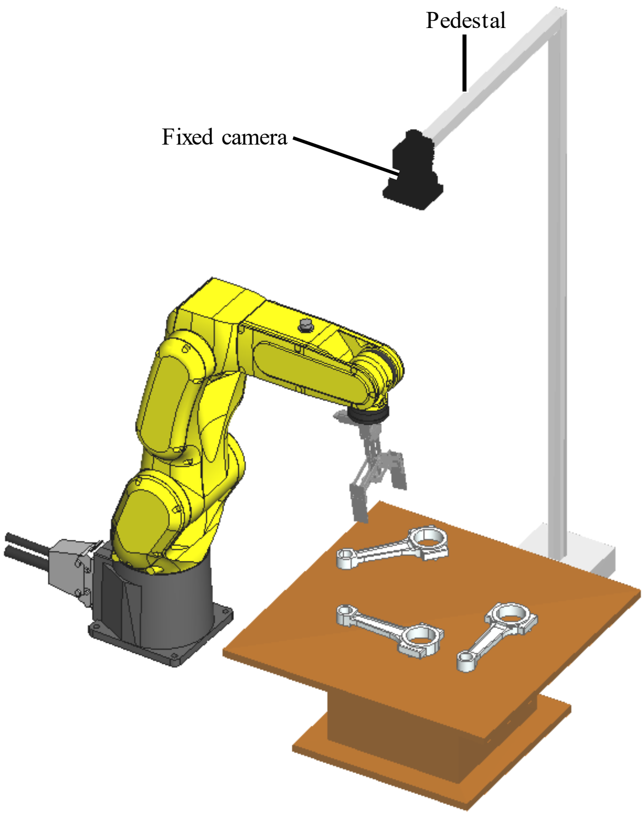
For how to connect the 3DV Sensor and the robot controller, refer to "Sensor Mechanical Unit/Control Unit OPERATOR'S MANUAL B-83984EN." Since the camera and lens used for 2D offset are also used for the 3DV Sensor, 2D offset can be performed using the camera and lens for the 3DV Sensor.

1.3 FIXED CAMERA AND ROBOT-MOUNTED CAMERA

The size and position of a part determines where a camera is installed.

Fixed Camera

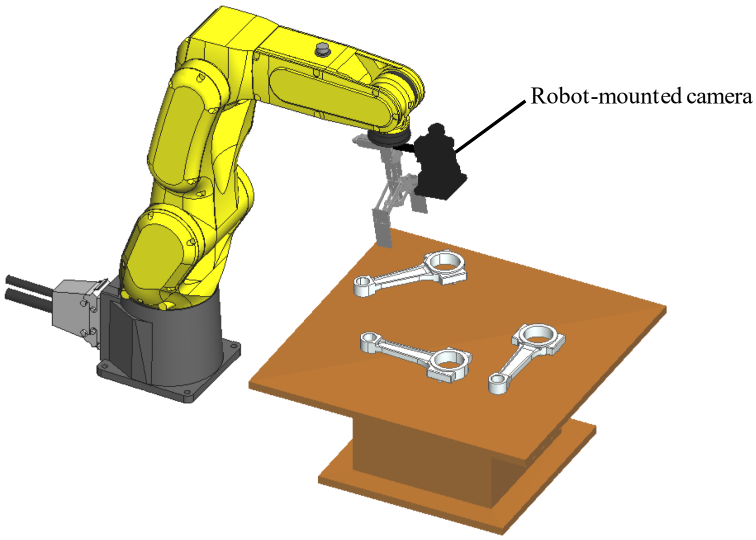
- A fixed camera is attached to the top of the pedestal or another fixed structure and a part is detected.
- A fixed camera always snaps the same place from the same distance.
- As processes in *i*RVision can be done in parallel when the robot is carrying out other work, the whole cycle time can be shortened.
- Use a pedestal for a fixed camera that is sturdy enough to be unaffected by vibrations.



Fixed Camera

Robot-mounted Camera

- The robot-mounted camera is mounted on the wrist unit of the robot.
- By moving the robot, measurement can be done at different locations between the part and the camera.
- When a robot-mounted camera is used, *i*RVision calculates the position of the part while taking into account the camera movement resulting from the robot being moved.
- The camera cable moves according to the robot movement, so be careful so that the cables don't get tangled.



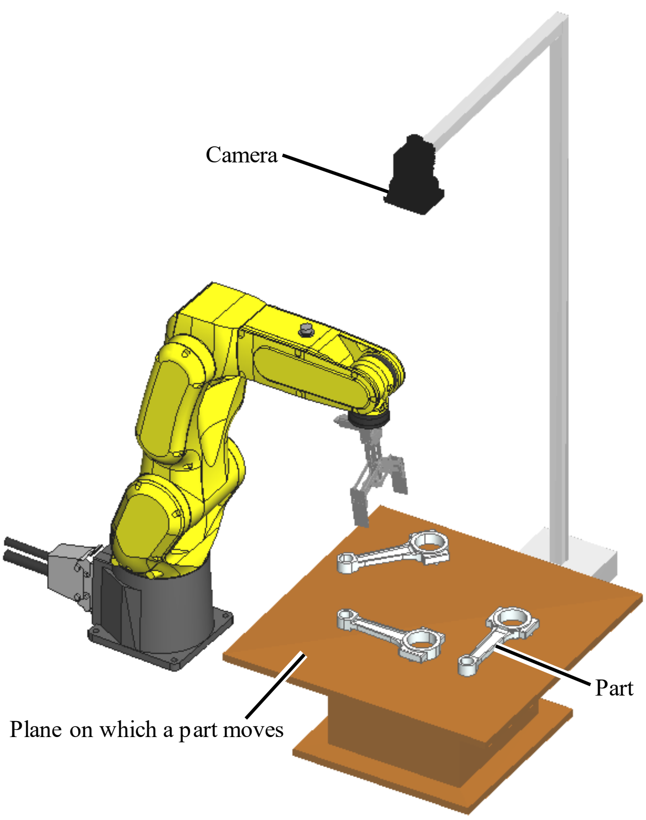
Robot-mounted Camera

1.4 FIXED FRAME OFFSET AND TOOL OFFSET

There are two kinds of robot position offset, fixed frame offset and tool offset. *i*RVision supports both kinds of robot position offsets.

3D Fixed Frame Offset System

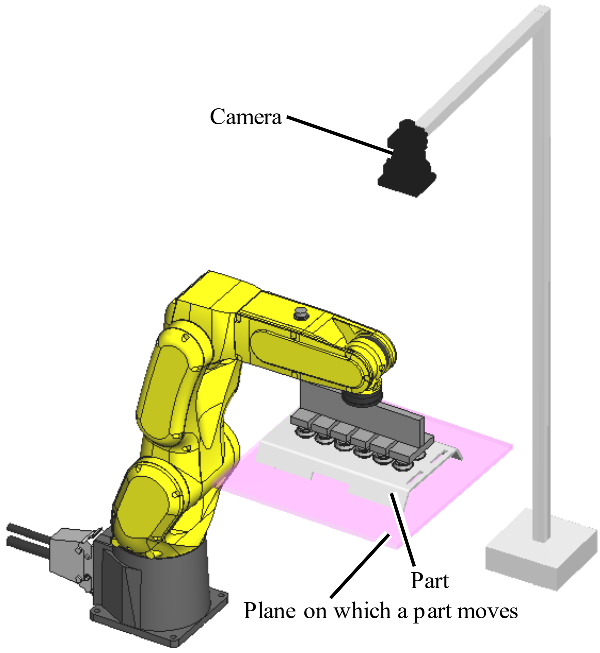
Fixed frame offset snaps an image of a part placed on a table, etc. with the camera, measures the discrepancy, and corrects the operation of the robot so that it will work on (e.g., grip) the part correctly.



Fixed Frame Offset

Tool Offset

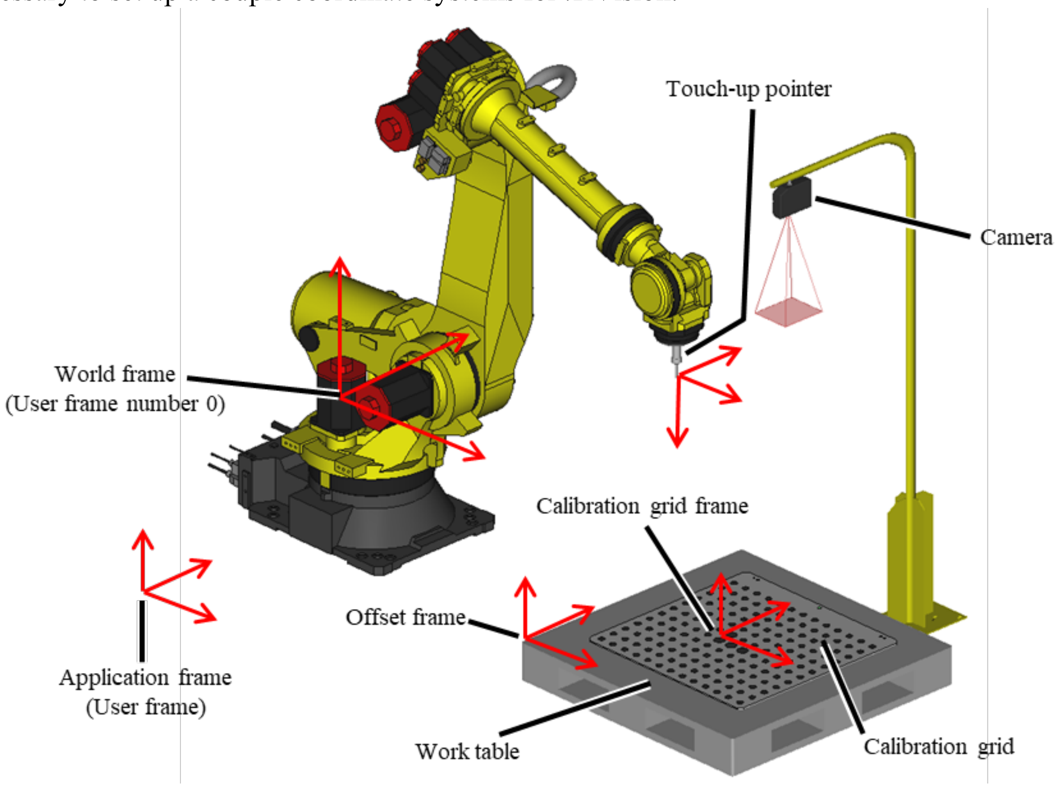
With tool offset, the workpiece offset is measured in a coordinate frame that moves with the robot tool. This method is useful for grippers where the part position in the gripper can vary, such as vacuum grippers. A workpiece held by the robot is viewed by a camera, and the vision system measures its position relative to the gripper. The robot then offsets its taught positions so that it can manipulate (place, for example) the workpiece properly.



Tool Offset

1.5 COORDINATE SYSTEMS USED FOR *i*RVision

It is necessary to set up a couple coordinate systems for *i*RVision.



Coordinate systems used for *i*RVision

Touch-up Pointer with Setting TCP

Set the TCP (tool frame) accurately on the touch-up pointer installed on the robot gripper. The touch-up pointer with TCP set is used for setting the application frame, installation information of the calibration grid, and the offset frame.

Offset Frame

An offset frame is a coordinate system used for calculation of the offset data. A found position, etc. of the part is outputted as a position on the frame set in the offset frame. Set the offset frame in such a way that the XY plane of the offset frame is parallel to the plane on which a part moves. For the fixed frame offset, set the offset frame as a user frame. For the tool offset, set the offset frame as a tool frame.

Calibration Grid Frame

Set the information of the calibration grid location in a user frame or tool frame. As shown in the above figure, when the calibration grid is fixed on a table for calibration, set the installation information in a user frame. When the calibration grid is installed on the robot end of arm tooling for calibration, set the installation information in a tool frame.
The installation information of the calibration grid can be set by touch-up using the touch-up pointer with TCP set. When a robot-mounted camera is used or a calibration grid is mounted on a robot end of arm tooling, the calibration grid frame setting function can also be used for setting.

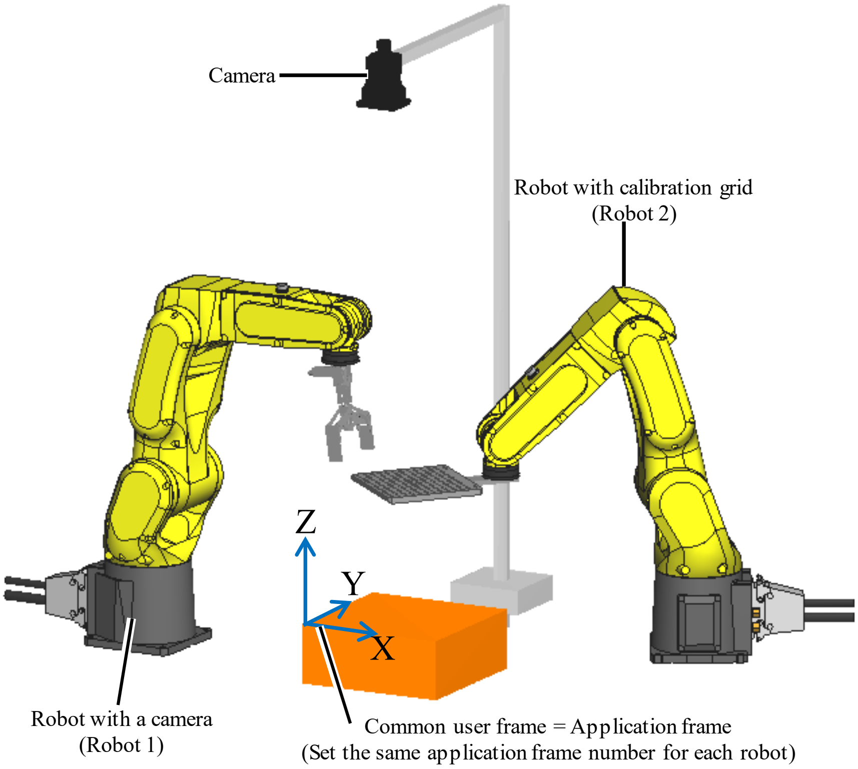
> **Memo**
> The calibration grid frame setting function sets the calibration grid frame using a camera. Compared with the manual touch-up setting method, this function offers a number of merits, including accurate setting of the frame without requiring user skills, no need for touch-up pointers or to set the TCP for touch-up setting, and semi-automatic easy operation. In calibration grid frame setting, the calibration grid is measured from multiple directions by using a camera. For details, refer to "Know-How: 1.2 FRAME SETTING WITH GRID FRAME SETTING FUNCTION."

Application Frame

Set the robot's user frame to be used as a reference for camera calibration. The camera is calibrated for the frame set in the application frame. In most cases, calibration is performed with reference to the world frame (user frame number 0) of the robot to be offset. Note that in the following cases, you set the user frame and then set the user frame number as the application frame.

- In cases where the camera is mounted on a robot other than the robot to be offset.
- In cases where the calibration grid is mounted on a robot other than the robot to be offset.
- In cases where the robot to be offset belongs to another group.

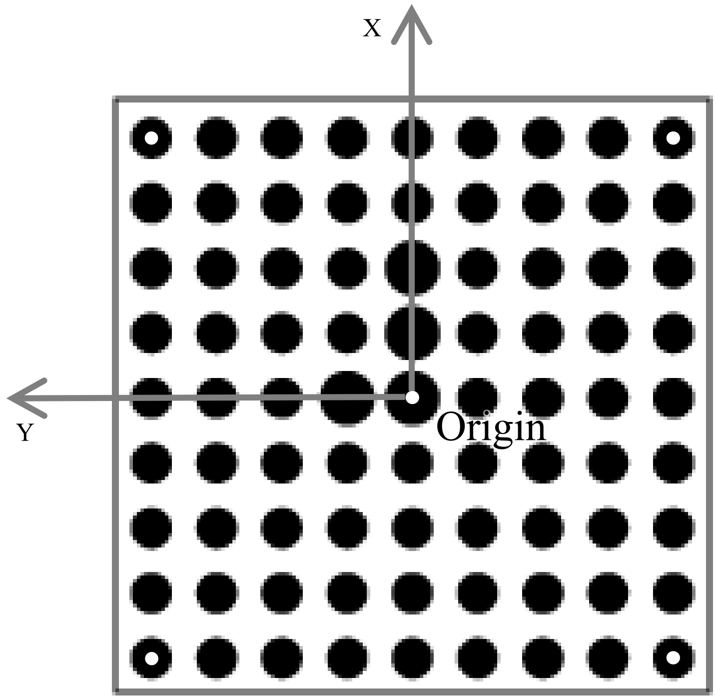
The following figure is an example of the calibration grid being mounted on a robot other than the robot to be offset. As shown in the following figure, when the robot with the camera mounted and the other robot with the calibration grid mounted are present, set the common plane as a user frame on both robots, and make it the application frame (set the same user frame number for each robot). In this example, inter-controller communication is required between the two robots. For details on communication between robot controllers, refer to the description of INTER-CONTROLLER COMMUNICATION in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."



Example of the calibration grid being mounted on a robot other than the robot to be offset

1.6 CALIBRATION GRID

A calibration grid is a multi-purpose jig that is used for a variety of purposes, such as grid pattern calibration and calibration grid frame setting.
In *i*RVision, calibration of a camera is performed using a calibration grid with a default pattern drawn. When the camera snaps an image of the grid as shown below, *i*RVision automatically recognizes the positional relationship of the calibration grid and the camera, lens distortion, the focal distance, etc.



Example of frame using calibration grid

All the black circles of the calibration grid are arrayed in a square lattice. There are four large black circles near the center that indicate the frame origin and direction as shown in the picture. The ratio of the diameter of a large black circle to that of other black circles is approximately 10:6.

For the five grid points arranged in the center and at the four corners, there is a white circle with a diameter of 1 mm placed at the center of the black circle. This white circle is used when setting the frame with touch-up using the robot's TCP.

Depending on the application, a calibration grid can be used by fixing it to a table or attaching it to the robot's gripper. In either case, it is necessary to set the arrangement position and direction (mounting information) of the calibration grid when performing calibration for the camera.

To set up the information for mounting the calibration grid, attach a pointer tool to the robot's gripper and set it up by physically performing touch-up (calibration grid setting using touch-up), or set it up automatically without any contact by using a camera and measuring a grid pattern (calibration grid frame setting).

1.7 MEMORY CARD PREPARATION

*i*RVision can save undetected images to a memory card or a USB memory inserted into the robot controller. It is recommended that at the time of system start-up and integration, a memory card or a USB memory be inserted to save undetected images to the memory card or a USB memory. By doing so, the locator tool parameter can be adjusted using undetected images. Moreover, when the system is reinstalled after being moved, e.g., camera images before reinstallation, if saved, can be checked against camera images after reinstallation to see if there are any major differences.
To enable vision log, check "Enable logging" on the *i*RVision configuration screen. For details, refer to the description of VISION CONFIG in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Note that even if "Log Failed Images" is set in the vision process, no undetected images can be saved when no memory card or no USB memory is inserted.
When the free space of the memory device is less than the specified value (1 MB by default), old vision logs are deleted to make enough free space for writing a new vision log. Even if the free space of the memory card/USB memory is less than the specified value, files other than vision logs of the vision system are not deleted. If there are no vision logs that can be deleted, the 'CVIS-130 No free disk space to log' alarm is posted and the vision log will not be recorded.

⚠ **CAUTION**

1. As it takes a long time to delete the vision log, we recommend that you regularly transfer the data for the vision log to your PC and ensure you have sufficient free space in your memory card or USB memory. For details on how to export the vision log to an external device or to delete it, refer to the description of VISION LOG in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
2. Data other than a vision log for *i*RVision may be recorded on a memory card or USB memory. If the free space drops below the designated capacity, the next time a vision Process is executed, vision logs will be deleted until the remaining capacity reaches the designated capacity. Depending on the amount of data that is deleted, it may take a while to get into a state in which execution of the next Vision Process can start. E.g., saving a backup to a memory card or USB memory corresponds to this case.
3. Do not insert a memory card in which a vision log has been recorded using another robot controller. If you carry out line execution or test execution of a vision process with the memory card still inserted, the vision log that was recorded using the original robot controller may be overwritten.
4. Format devices such as memory cards and USB memory to FAT16.
5. If you record images, it may take time to execute detection. Basically, set things up so that images will not be recorded after you have finished adjustment of the vision system. For details, refer to the description of VISION LOG in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

A memory card or a USB memory, when inserted, can be used to back up all data in the robot controller. If all data in the robot controller is backed up, the vision data can be backed up at the same time. Be sure to back up all data in the robot controller upon completion of startup or integration.

Moreover, use a memory card provided by FANUC. Use a USB memory recommended by FANUC. If a memory card or a USB memory other than those recommended is used, normal operation is not guaranteed, and it may have a bad effect on the controller.

Setup

1 FEATURES

There are the following offset applications for the 3DV Sensor

1 3D fixed frame offset.
2 3D tool offset
3 Bin Picking

In each offset application, a robot-mounted camera or a fixed camera can be selected.
However, 3D tool offset using robot-mounted camera is not supported.

Chapter 2 and subsequent chapters of this part describe the flow of the startup procedure and the details of the teaching procedure for the following vision systems using the 3DV Sensor.

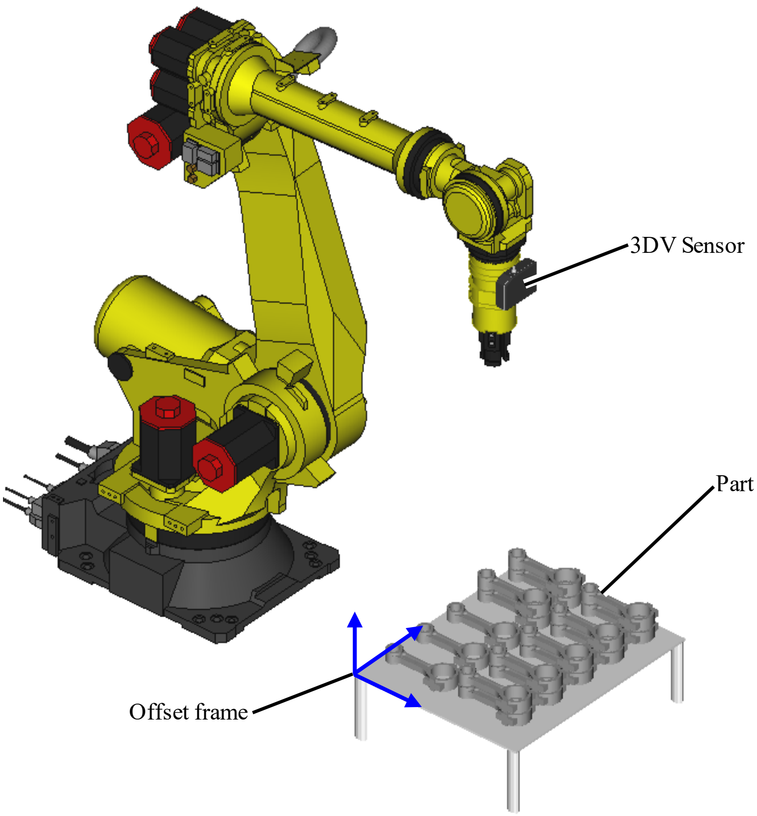
1 Robot-mounted camera + 3D fixed frame offset (single-view / multi-view)
2 Fixed camera + 3D fixed frame offset
3 Fixed camera + 3D tool offset (single-view / multi-view)
4 Fixed camera + Bin Picking

In general, multi-view offset has higher accuracy and longer cycle time than single-view offset.

For details on each teaching item, refer to the descriptions of VISION PROCESSES and COMMAND TOOLS in “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”

Layout Example

This section describes a typical system layout of the 3DV Sensor system and provides notes on setup. Use a robot-mounted camera or a fixed camera.



Layout example

Precautions

- With the automatic exposure or multi-exposure function, *i*RVision can handle changes in brightness to some extent. In a place where there is a large difference in illumination between day and night, however, some measures must be taken to keep a certain level of illumination at all times. Major methods include shutting out the sunlight and installing a fluorescent lamp.
- When lighting such as a fluorescent lamp is installed, the inverter type is suitable. This type has less variation in brightness when an image is snapped. When lighting is provided for a wider area than the part installation area, there is less variation in brightness in the image of a part even if the part is tilted.
- To perform fixed frame offset, set a user frame as required. It is recommended that the end of arm tooling be designed in advance so that a touch-up pin can be mounted.
- To perform tool offset, a calibration grid must be mounted on the robot or teaching part. It is recommended that the end of arm tooling be designed in advance so that a calibration grid can be mounted.
- When robot motion offset is performed, the wrist axis may turn by a large angle. Prepare a cable long enough for such robot behavior.
- If the installation position of the 3DV Sensor is displaced from the right position, accurate offset cannot be performed. The risk of displacement due to interference and so on can be reduced by installing a guard for the sensor.
- The 3DV Sensor is designed so that the distance to the part during measurement stays within a certain range. Check the following points when teaching.
  1. Whether the robot can reach all the measurement positions.
  2. Whether the hand and the 3DV Sensor do not interfere with peripheral equipment during measurement.
  3. Whether an appropriate measurement distance can be secured.

  For the detection range, refer to “Sensor Mechanical/Control unit OPERATOR'S MANUAL B-83984EN.”
- When the 3DV Sensor is to be mounted on the robot and used as a robot-mounted camera, mount it on such a place that the sensor does not touch a part, container, or peripheral equipment when the robot picks up the part as well as when the sensor is used for measurement.

2 3D FIXED FRAME OFFSET SYSTEM

2

This chapter describes the procedures of how to set up the 3D fixed frame offset system using a robot-mounted camera or a fixed camera.

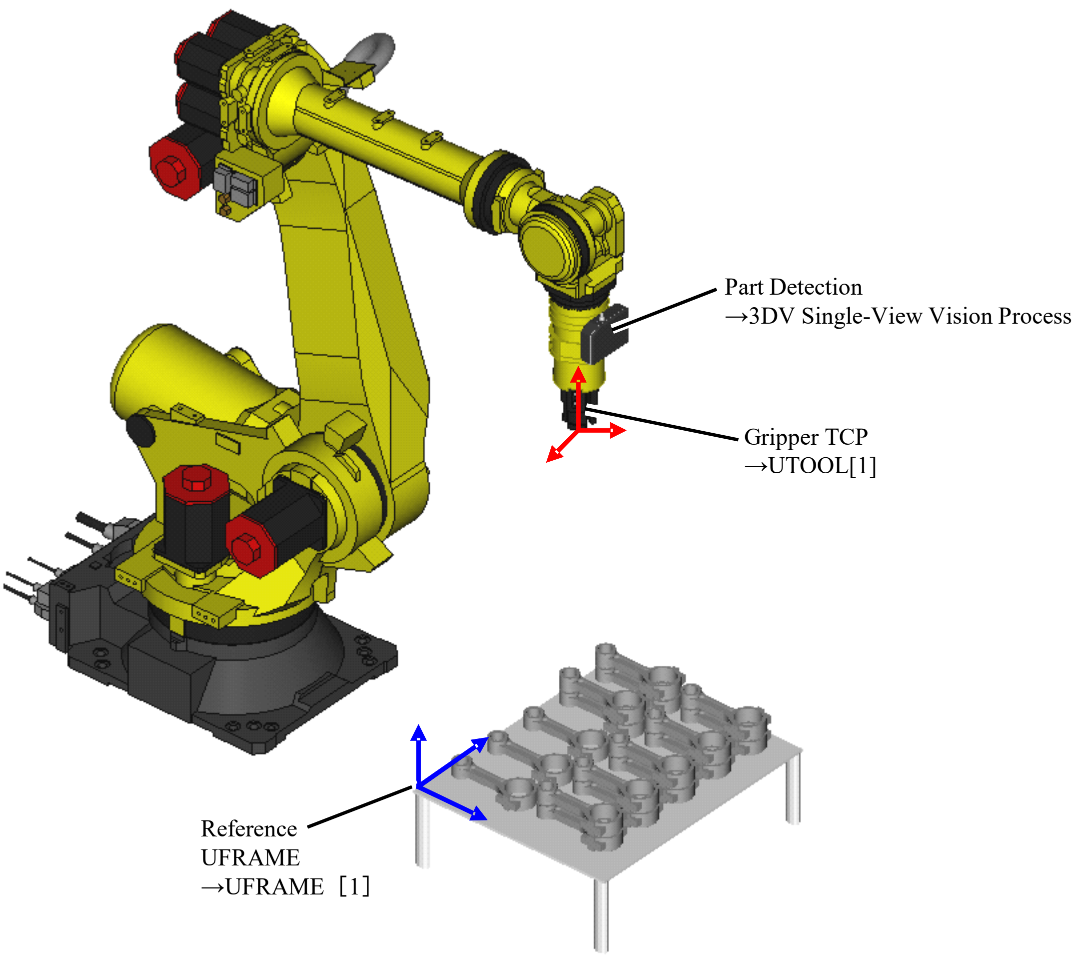
Memo

1 This chapter describes the screens and operations in the simple mode unless otherwise noted. For details on the Simple Mode and Advanced Mode, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2 With a controller that can use a tablet TP, the 3D fixed frame offset system can also be taught using a tablet TP. For details, refer to "Tablet UI OPERATOR'S MANUAL B-84274EN."

2.1 3D SINGLE-VIEW FIXED FRAME OFFSET SYSTEM USING ROBOT-MOUNTED CAMERA

This section explains the setup procedures for the 3D fixed frame offset system using a robot-mounted camera to measure one location in the figure below as an example.



Example of a 3D single-view fixed frame offset system configuration using robot-mounted camera

2.1.1 Installation and Connection of 3DV Sensor

Installation of the 3DV Sensor

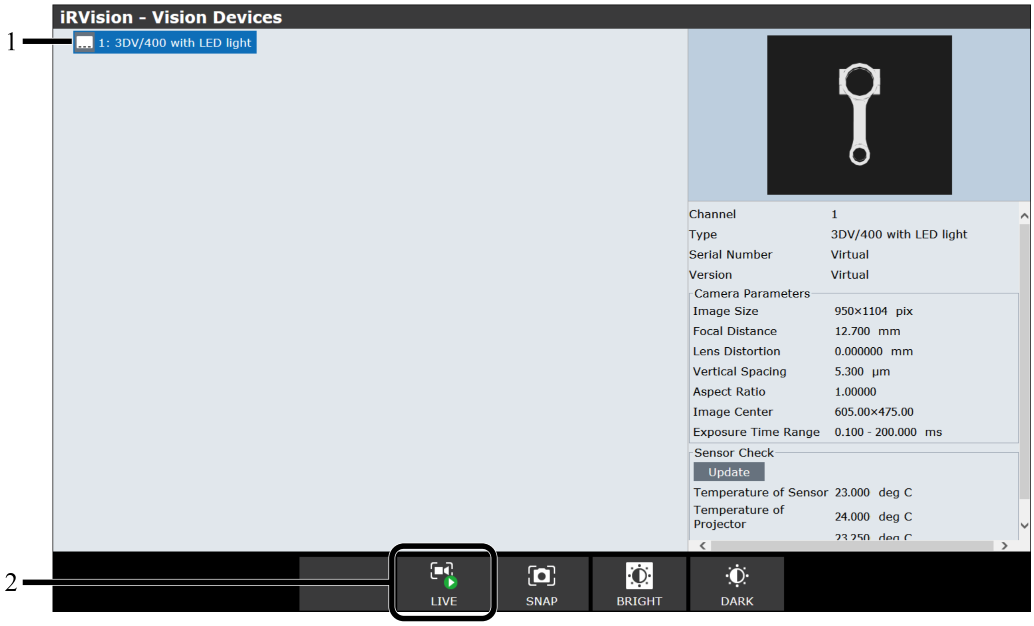
Install the 3DV Sensor on the wrist of the robot.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.

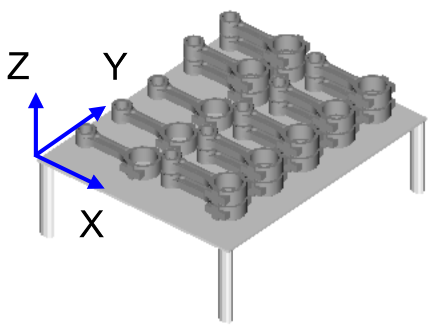


1 On the ROBOT Homepage, select [*i*RVision] → [Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.

2 Click [LIVE] and check that continuously snapped images are displayed.

2.1.2 User Frame Setting

Set the user frame which becomes the reference frame for an offset calculation. Set it on the work table as shown in the figure below. For how to set up the user frame, refer to “Know-How: 1 FRAME SETTING.”



Example of user frame setup

Here, set the user frame to UFRAME [1] as described in the figure ‘Example of a 3D single-view fixed frame offset system configuration using robot-mounted camera ’ at the beginning of this section.

2.1.3 3DV Sensor Data Setting

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the robot-mounted camera according to the procedures described in “Know-How: 2.1 3DV SENSOR MOUNTING POSITION SETUP WITH ROBOT-MOUNTED CAMERA.”
This system has pre-installed sample 3DV Sensor Data. It is convenient to configure the settings based on the sample. This chapter explains the operations assuming that the sample 3DV Sensor Data will be used.

2.1.4 Tool Frame Setting

Set a tool frame in the center of the end of the gripper claw or the pad to pick up a part. This frame is useful for accurately moving the TCP of the gripper to the part gripping position.
The Z-axis of this frame should be set along the direction in which the gripper approaches the part to be picked up. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure ‘Example of a 3D single-view fixed frame offset system configuration using robot-mounted camera ’ at the beginning of this section. For how to set up the tool frame, refer to “Know-How: 1 FRAME SETTING.”

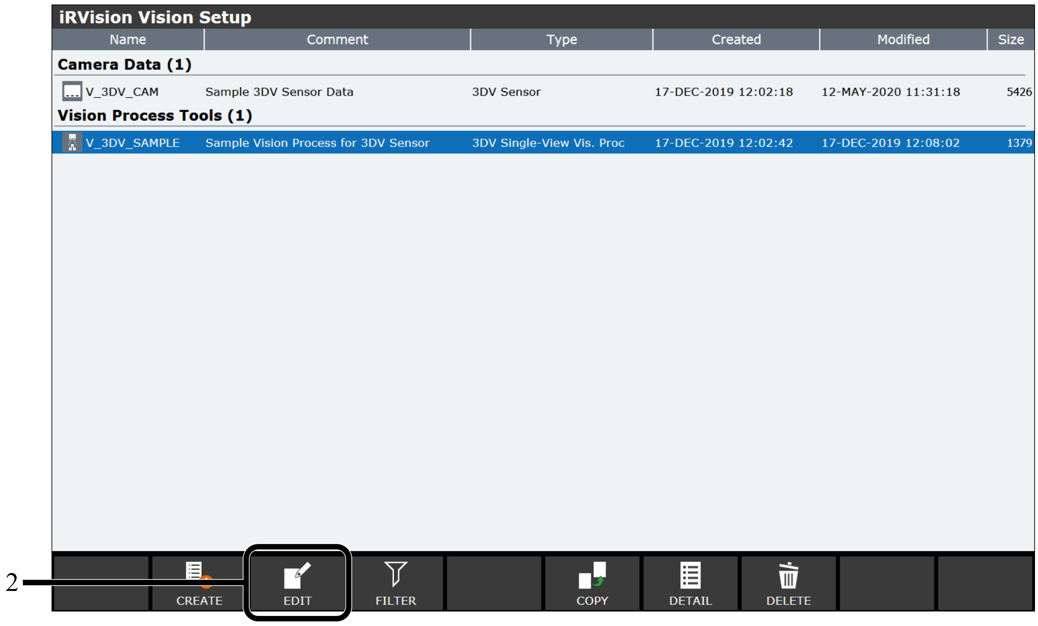
2.1.5 Setting up Vision Process

Set up a “3DV Single-View Vision Process.”
This system has a pre-installed sample vision process. The following explains the procedure for editing the settings based on that sample.

2.1.5.1 Editing vision process

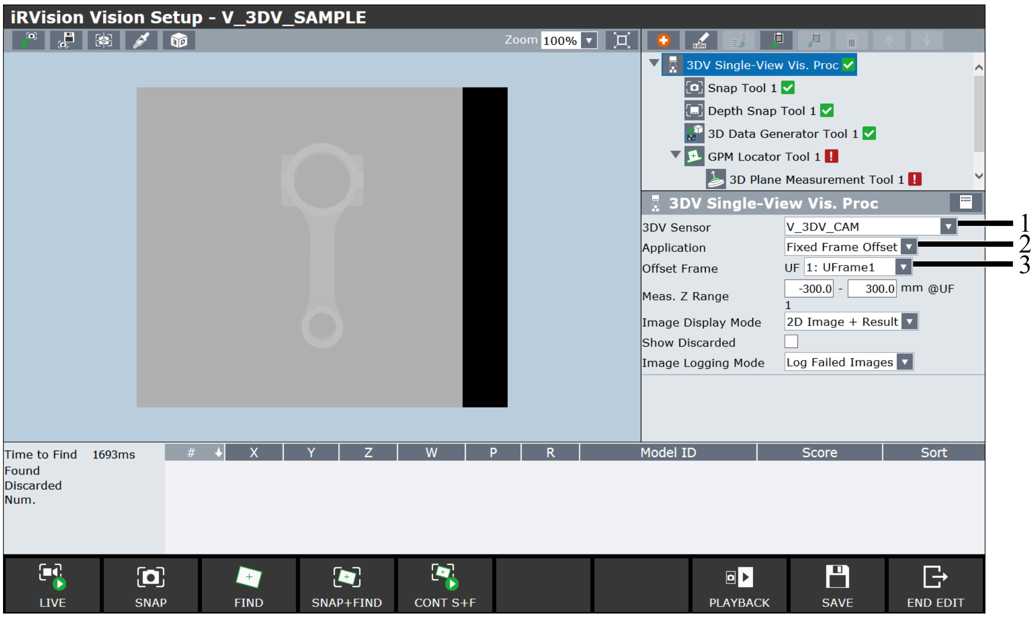
Select the sample vision process and open the edit screen.

1 Click [V_3DV_SAMPLE] in the [Vision Process Tools] category on the vision data list screen.



2 Click [EDIT].
The vision process setup screen appears.

2.1.5.2 Setting parameters of vision process



1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 Select [Fixed Frame Offset] from the [Application] drop-down box.
3 Select [1] from the [Offset Frame] drop-down box.
Offset frame is the user frame used for calculation of offset.
Select the user frame number set in “Setup: 2.1.2 User Frame Setting.”
4 Jog the robot to the position where the 3DV Sensor and the offset plane face each other and the offset plane is within the 3DV Sensor’s field of view.
5 Teach the current position as the part detection position in the robot program.
This system has a pre-installed sample TP program for fixed frame offset. The details are described in “Setup: 2.1.6 Editing TP Program.” The part measurement position is P [2] on the seventh row in the sample TP program.

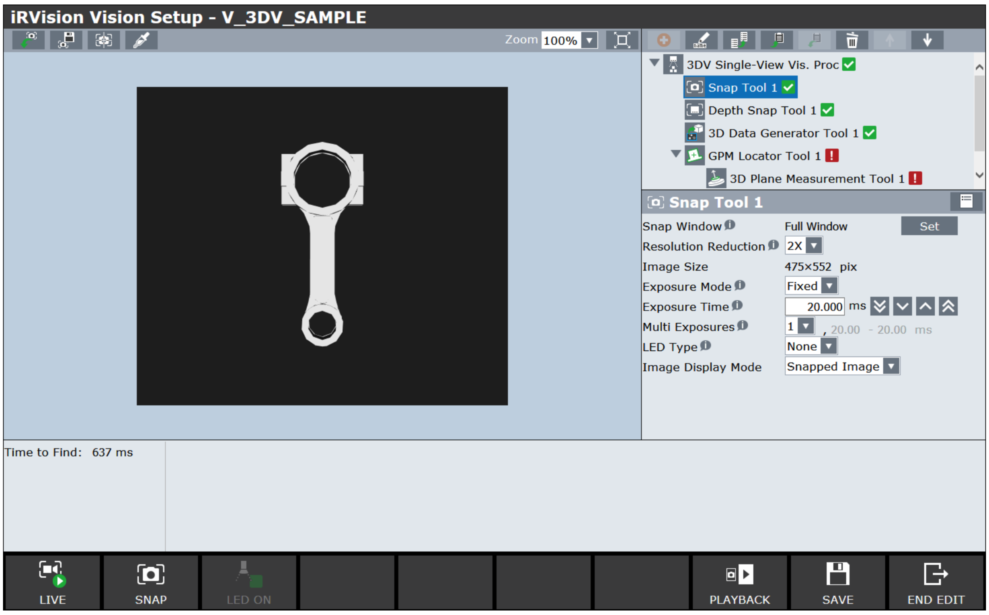
Memo

If you click [icon] to switch to advanced mode, you can enable/disable [Camera Base Find]. When the checkbox of [Camera Base Find] is checked, a part is found based on the frame of the 3DV Sensor. When mounting the sensor to the robot, the sensor snap position changes according to the movement of the robot. For this reason, you should normally enable [Camera Base Find] to find a part.

2.1.5.3 Teaching Snap Tool

Set parameters for snapping 2D images.

Select [Snap Tool 1] in the tree view to open the snap tool teaching screen. In most cases, you can use the initial settings for the sample as they are. However, if the image is too dark or bright, adjust [Exposure Time] or select [HDR] in [Exposure Mode].
For details on the snap tool, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."



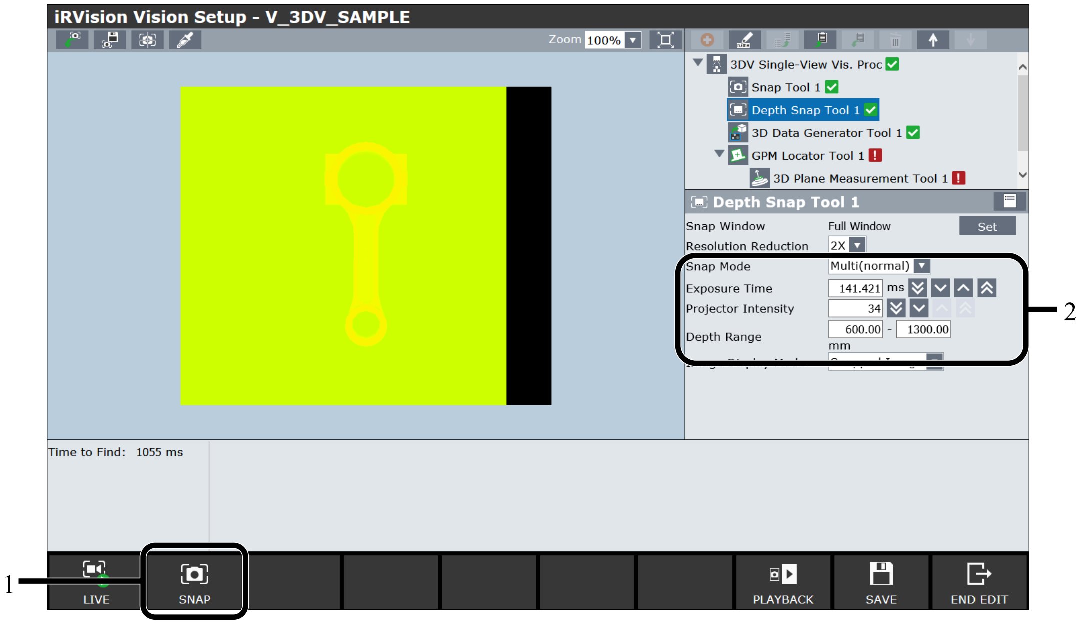
Memo

1. If the image is still too dark even when the exposure time is set to the maximum (200 ms), change [LED Type] to [3DV Sensor] and then adjust the "Exposure Time."
2. The [HDR] option of [Exposure Mode] combines images snapped at multiple exposure times, automatically selected according to the surrounding brightness, into a single image with a wide dynamic range.

2.1.5.4 Teaching Depth Snap Tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



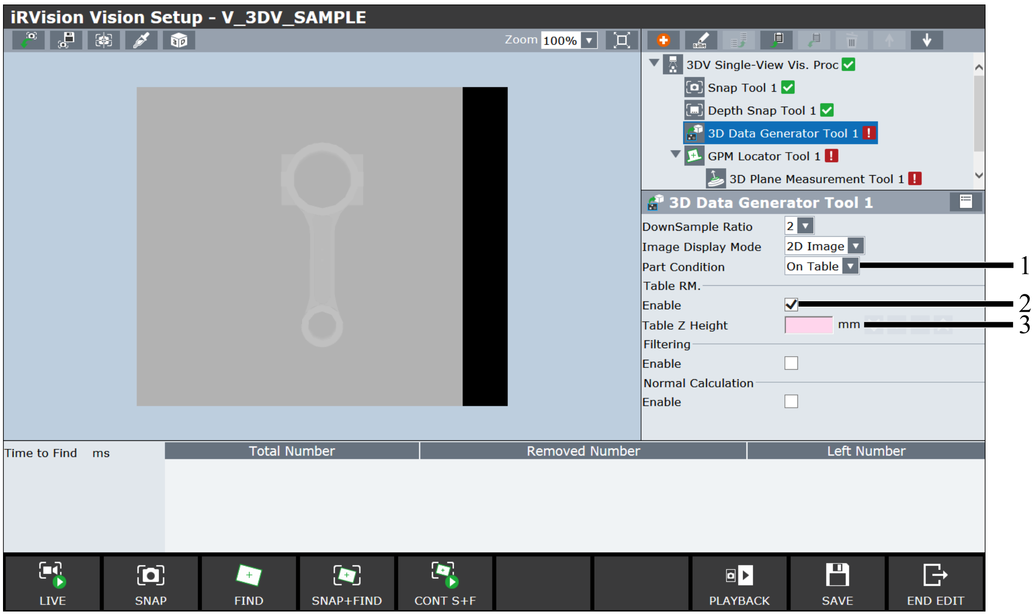
1 Click [SNAP].
2 Adjust each parameter so that measurement omission (black area) will be reduced.
For details on each parameter, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Repeat the procedure starting from step 3 until the parameters are adjusted appropriately.

Memo
Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to "Setup: 2.4 3D VISION SENSOR" in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.1.5.5 Setting parameters of 3D Data Generator Tool

Select [3D Data Generator Tool 1] in the tree view, and then set each item.

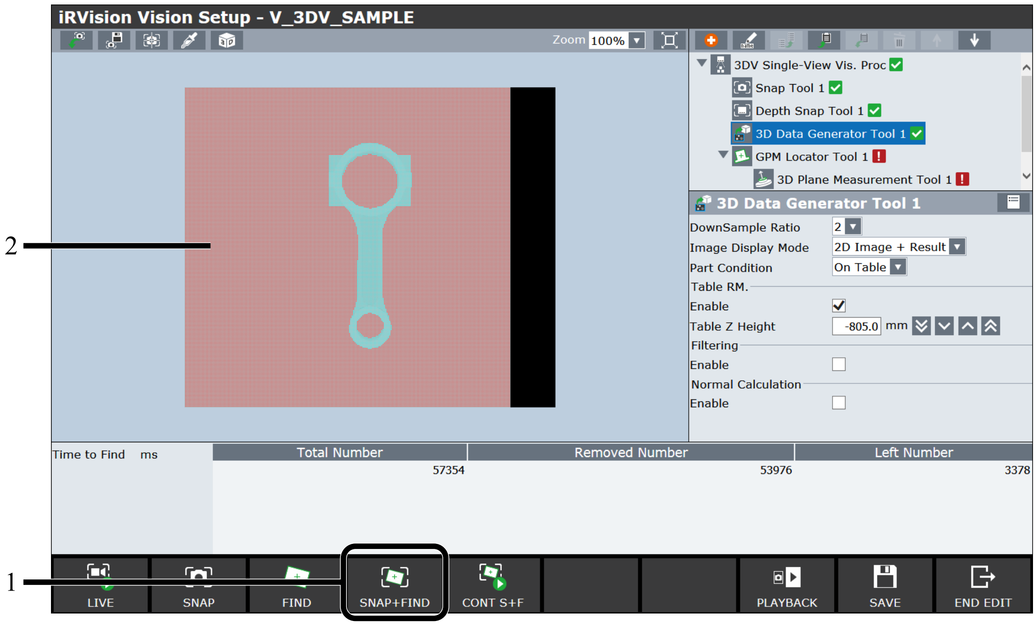
Setting parameters



1 Select [On Table] from the [Part Condition] drop-down box.
2 Check the checkbox of [Enable] in [Table RM.].
3 Set [Table Z Height].
This parameter is the height from the 3DV Sensor to the offset plane, which is normally a negative value. It represents the Z height on the camera frame.

Running a test

Check that unnecessary 3D points for part detection have been removed correctly.



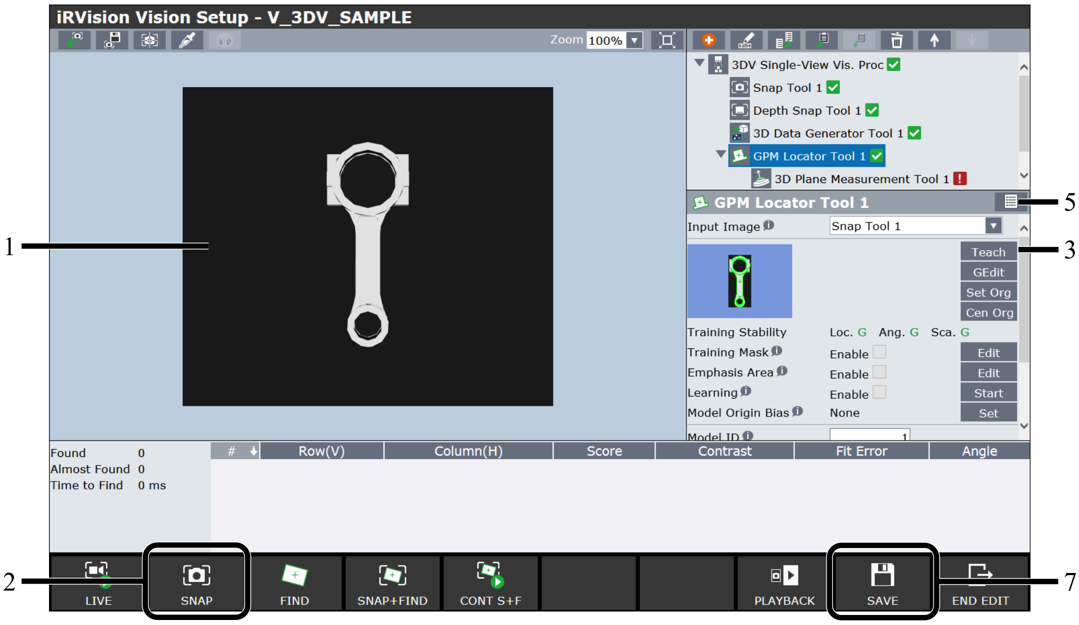
1 Click [SNAP+FIND]. An image is snapped and detection is performed.
2 Check that unnecessary 3D points for part detection have been removed correctly.
The area displayed in red is a removed 3D point group. Check whether the area other than the part is displayed in red.

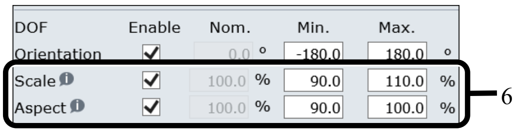
> **Memo**
> If the 3D points on the table plane are not removed, fine-tune the "Table Z Height."

2.1.5.6 Teaching GPM Locator Tool

Set parameters for 2D measurement (detection of 2D features).
Select [GPM Locator Tool 1] in the tree view, and then set each item.

Setting parameters





DOF	Enable	Nom.		Min.	Max.	
Orientation	✓	0.0	°	-180.0	180.0	°
Scale	✓	100.0	%	90.0	110.0	%
Aspect	✓	100.0	%	90.0	100.0	%

1 Move the robot so that the part is in the field of view of the camera.
2 After determining the measurement position, click [SNAP] to capture an image.
3 Click the [Teach] button to teach the model.
The GPM Locator Tool model setup screen appears. Teach 2D features used for position detection. Select features of the model on the same plane as much as possible to reduce the effects of changes in shape due to parallax. For features that do not need to be included in the model, [Training Mask] can be set to exclude them from the teach model. For details on teaching 2D features, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
4 Check that the pattern that you want to use as the model has been plotted with a green line and that the model origin (green cross) is on the same plane as the pattern.

> **Memo**
> If the model origin is not on the same plane as the pattern, click the [Set Org.] button and move the model origin onto the same plane as the pattern.
> In the above example, the model origin is changed to be on the plane (large circle of the part) at the highest position of the part.

5 Click to switch to advanced mode.
6 Check the checkboxes of [Scale] and [Aspect] in [DOF].

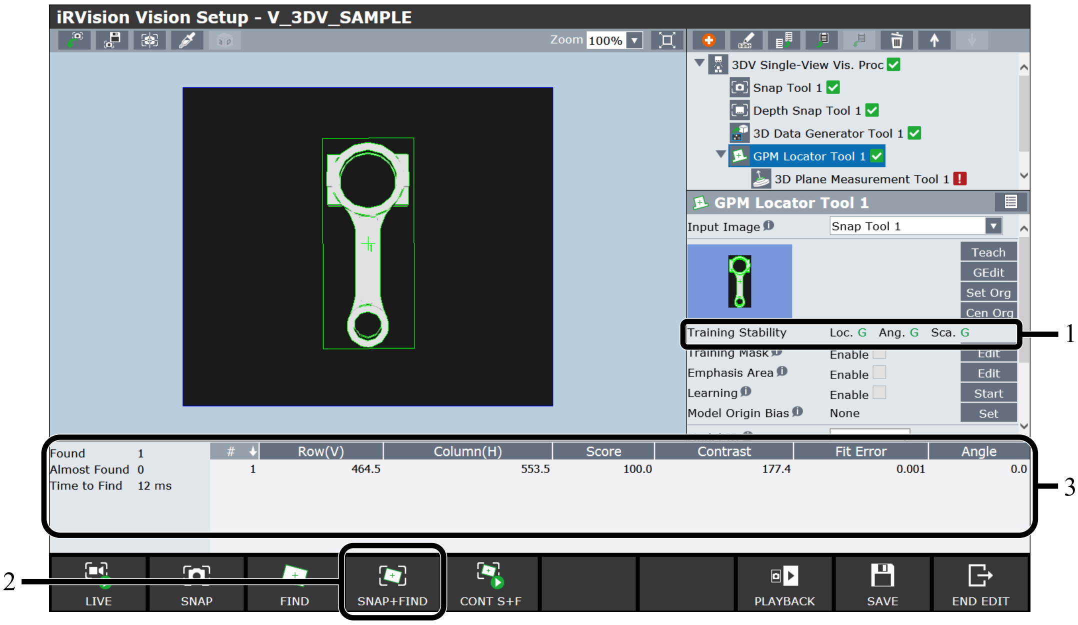
2

Memo

Change the [Min.] and [Max.] settings for [Orientation], [Scale], and [Aspect] in [DOF] as necessary. If the distance between the camera and the part varies widely, consider expanding the [Scale] search range setting. If the tilt between the camera and the part varies widely, consider expanding the [Aspect] search range setting. Also, if misdetection of the part seems to increase, consider decreasing the search range parameters. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

7 Click [SAVE].

Running a test



1 Check [Training Stability]
This item provides a guideline indicating whether the position, angle and size are detected correctly in the taught model. Evaluations are indicated with [G] (good), [P] (poor) and [N] (none). [N] indicates that stable detection of the model may be impossible.
In such a case, change the model, or uncheck [Enable] for the parameter in question in [DOF].

2 Click [SNAP+FIND].
An image is snapped, and detection is performed.

3 Check measurement results.
Check that the same pattern as the model has been plotted with a green line. Then, check the score, contrast, and other results of the detected model on the test result display area. If the score and contrast values are higher than the set thresholds by at least 10 points, there is no problem.

Memo

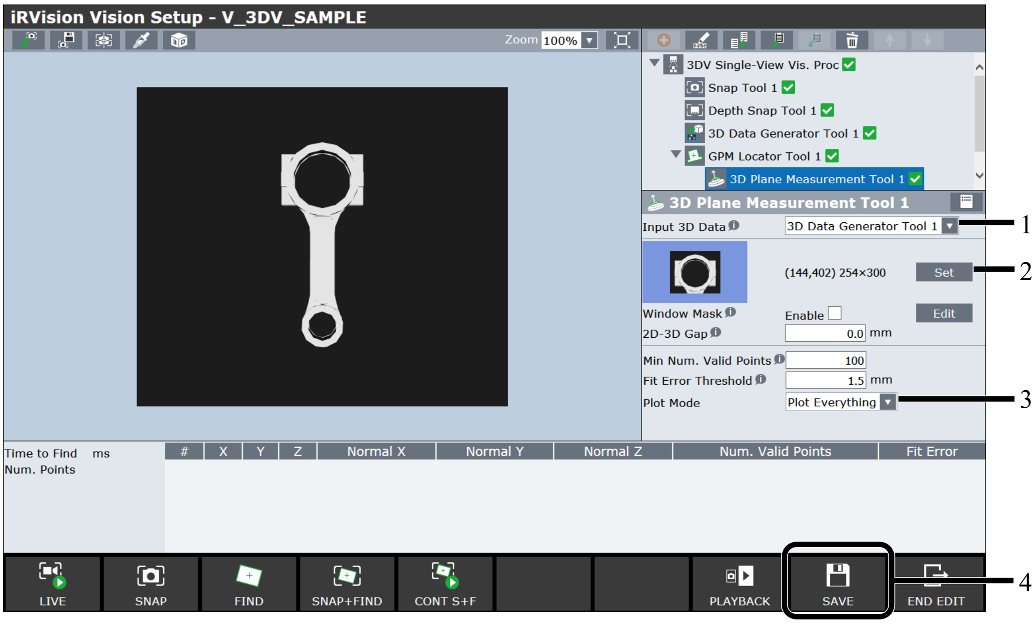
Adjust parameters of the GPM Locator Tool if there is a problem. Some parameters are displayed only in the advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

4 Change the part position and repeat the same check several times.

2.1.5.7 Setting up 3D Plane Measurement Tool

Set parameters for detecting the plane near the 2D feature position detected with the GPM Locator Tool from 3D points. Select [3D Plane Measurement Tool 1] in the tree view, and then set each item.

Setting parameters



1 Select [3D Data Generator Tool 1] for [Input 3D data].

2 Click the [Set] button.
The green lines shown in the image are the model and the area taught with the GPM Locator Tool, and the area inside the red frame is the plane measurement area. When the measurement area is taught at first, the red frame will be shown overlapping the green frame, but this can be changed. For details on the measurement area teaching screen for plane measurement, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Once the measurement area has been taught, a thumbnail of the image used for teaching appears, and the position and size of the area appear.

> **Memo**
> If the model origin for the GPM Locator Tool is not in the plane you want to measure, change [2D-3D Gap]. If the model origin is above the Z direction as seen from the plane you want to measure, specify a positive value for this setting. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

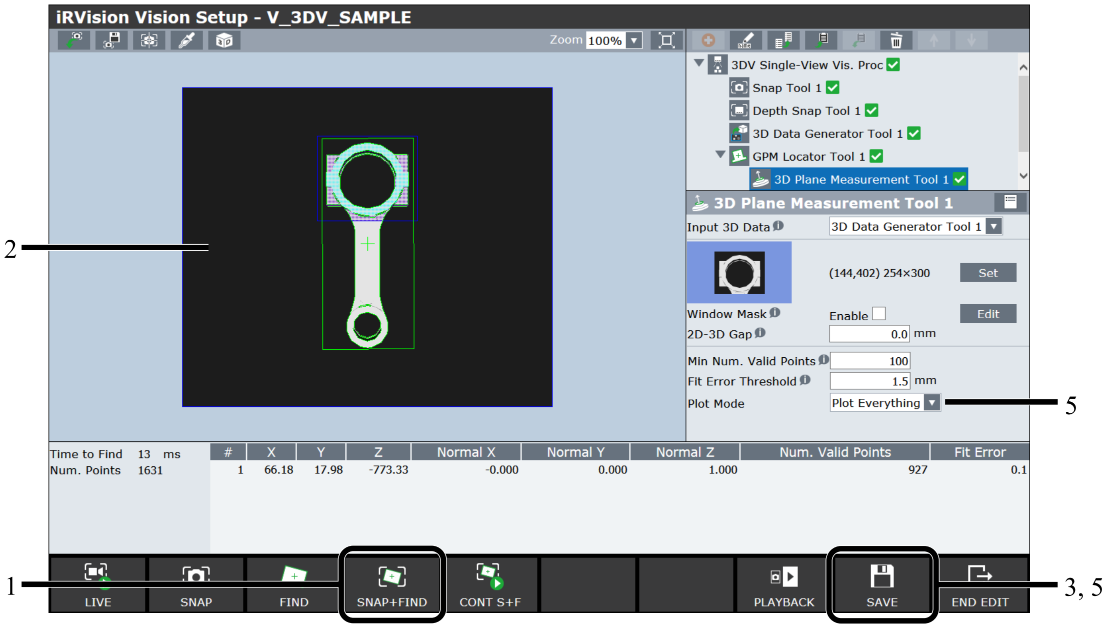
3 Select [Plot Everything] from the [Plot Mode] drop-down box.

4 Click [SAVE].

> **CAUTION**
> Before setting the 3D Plane Measurement Tool, complete the setting of the GPM Locator Tool. Also, the measurement area must be taught again if the model of the GPM Locator Tool is changed.

Running a test

Check whether the taught area is appropriate. If necessary, adjust parameters to enable stable detection.



1 Click [SNAP+FIND].
  An image is snapped and detection is performed.

2 Check that a light blue plot is displayed on the surface of the part that you want to measure.

Memo

1 Adjust parameters of the 3D Plane Measurement Tool if there is a problem. For example, if a light blue plot is displayed on a surface other than the one that you want to measure, teach [Window Mask]. Also, some parameters are displayed only in advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2 In the above example, the measurement area is taught so that the plane (the large circle section shown on the part) at the highest position of the part will be measured. Change the measurement area according to the shape of the part.

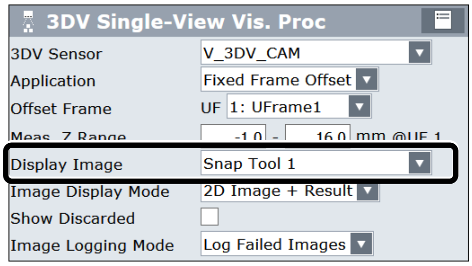
3 Click [SAVE].

4 Repeat steps 1 to 4 by changing the tilt of the plane.

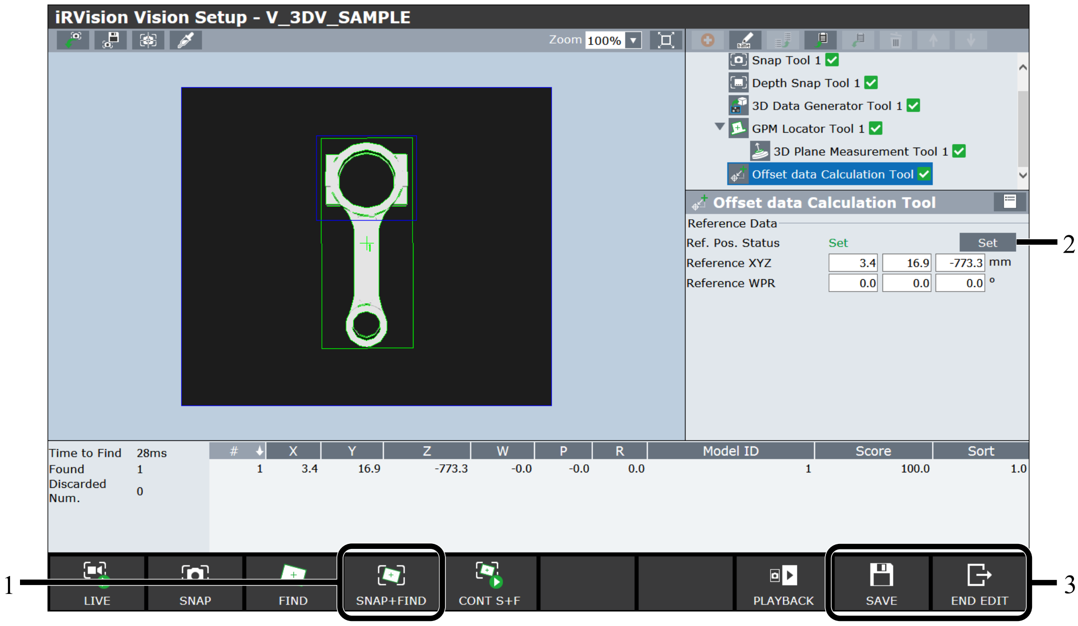
5 If there is no problem with the test run, change the option for [Plot Mode] to [Plot Measurement Area] and click [SAVE] again.

2.1.5.8 Setting reference position

Here, place a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.
In preparation, select [3DV Single-View Vis. Proc] in the tree view, and select [Snap Tool 1] for [Display Image].



Then, select [Offset data Calculation Tool] in the tree view, and then set each item.



1 Click [SNAP+FIND] to find the part.
2 Check that the part has been found correctly, and click the [Set] button of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

> ⚠ **CAUTION**
> From this point forward, do not move the part until teaching of the robot motion when the part is placed at the reference position is finished in the TP program for fixed frame offset.

2.1.6 Editing TP Program

Edit the TP program for the 3D fixed frame offset system with a 3DV Sensor.
This system has a pre-installed sample program. This section explains how to create a program for transporting a part while actually performing 3D fixed frame offset based on this sample program.

2

Copying the sample program

1 Select [V_3DV_FIXED] and click [COPY] on the program list screen.

2 Edit the program name and click [OK].

Editing the program

1 Open the copied program and teach the following positions.

Positions

P[1: Home]	Home position. The robot's waiting position and posture when it is not doing anything.
P[2: Search]	The detection position. The robot's position and posture when the sensor has found the part.
P[3: Pick Approach]	The approach position when picking the part. In most cases, it is right above the part that needs to be picked up.
P[4: Pick]	The part pick position. It is the position at which the part is actually picked up (grasped).
P[5: Pick Retract]	The pick retraction position. A relay point when moving from the pick position to the placement position.
P[6: Place Approach]	The placement approach position.
P[7: Place]	The placement position.
P[8: Place Retract]	The place retraction position. It can be the same position and posture as P[6].

```
UFRAME_NUM=1
UTOOL_NUM=1
J P[1:Home] 30% FINE

!SEARCH
LBL[10]
J P[2:Search] 100% FINE
WAIT    .30(sec)
VISION RUN_FIND 'V_3DV_SAMPLE'
VISION GET_OFFSET 'V_3DV_SAMPLE'
VR[1] JMP LBL[999]

!PICK
L P[3:Pick Approach] 800mm/sec CNT100
VOFFSET,VR[1]
L P[4:Pick] 200mm/sec FINE VOFFSET,VR[1]
!Insert program instructions
!to grasp the part.
CALL ...
L P[5:Pick Retract] 800mm/sec CNT100
VOFFSET,VR[1]

!PLACE
L P[6:Place Approach] 800mm/sec CNT100
L P[7:Place] 200mm/sec FINE
!Insert program instructions
!to release the part.
CALL ...
L P[8:Place Retract] 800mm/sec CNT100
JMP LBL[10]

!ERROR
LBL[999]
```

- UFRAME_NUM=1: Specify the user frame number set in "2.1.2 User Frame Setting".
- UTOOL_NUM=1: Specify the tool frame number set in "2.1.4 Tool Frame Setting".
- WAIT .30(sec): Wait for robot-vibration to reduce.
- VISION RUN_FIND: Execute measurement.
- VISION GET_OFFSET: Get the offset data in the measurement result and jump to the last row when not found.
- L P[4:Pick]: Move to the part pick position.
- L P[7:Place]: Move to the part placement position.

2 Specify the instruction to grasp the part and release the part after the P[4] and P[7] motion instructions, respectively, using each of the CALL instructions.

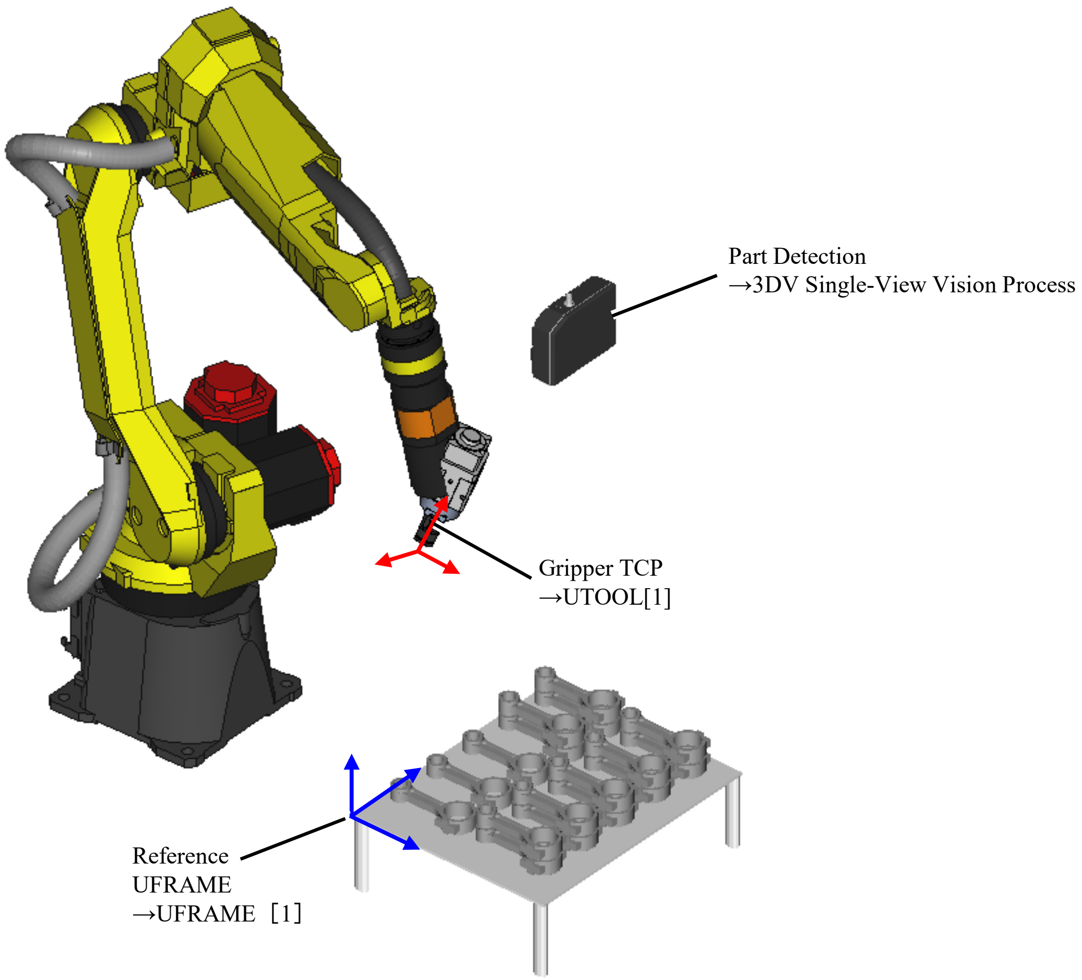
2.1.7 Checking Robot Offset Operation

Check that a part on the table can be detected and picked up accurately.
Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

- Place the part near the reference position, find it and check that it can be picked up accurately. If the accuracy of compensation is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation, find it and check that it can be picked up accurately.
- Rotate the part, find it and check that it can be picked up accurately. If the part on the reference position can be picked up accurately but the accuracy decreases as the part rotates, the settings of the calibration grid and of the frame used for offset may not have been performed accurately. If you set the frame with a pointer tool, check the accuracy of touch-up and retry calibrating the 3DV Sensor.
- Change the part's height, find it and check that it can be picked up accurately.
- Tilt the part, find it and check that it can be picked up accurately.

2.2 3D SINGLE-VIEW FIXED FRAME OFFSET SYSTEM USING FIXED CAMERA

This section explains the setup procedures of the 3D fixed-frame offset system using a fixed camera in the figure below as an example.



Example of a 3D single-view fixed frame offset system configuration using fixed camera

2.2.1 Installation and Connection of 3DV Sensor

Installation of the 3DV Sensor

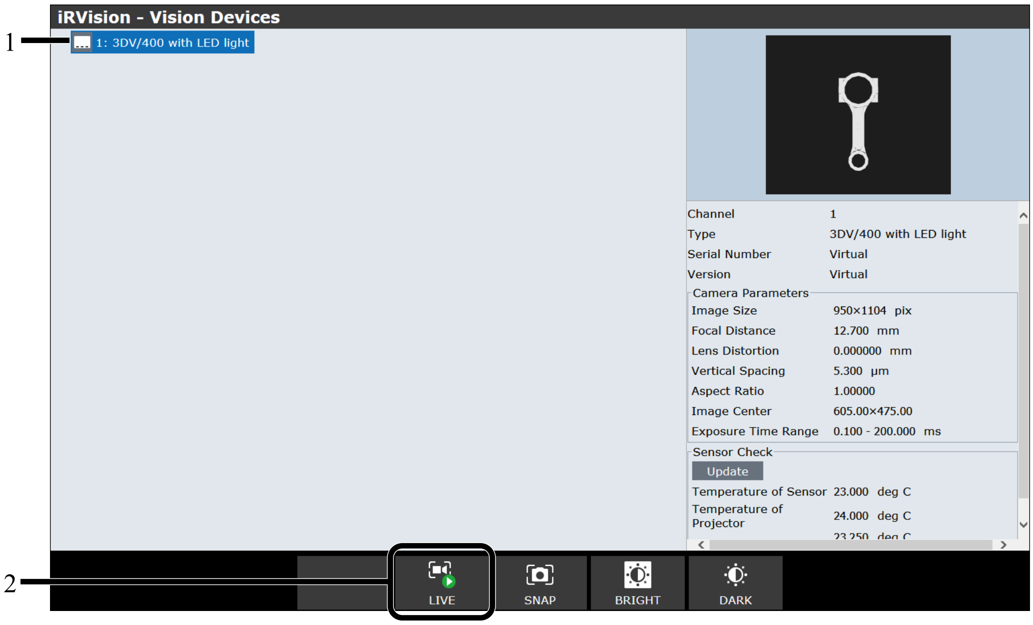
Install the 3DV Sensor on the camera mount.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.

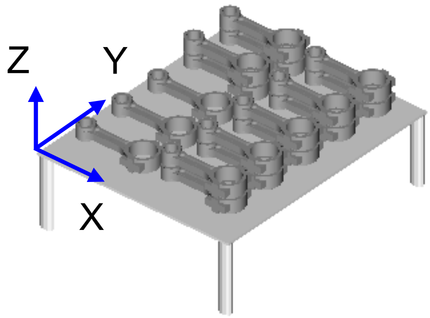


1 On the ROBOT Homepage, select [*i*RVision] →[Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.

2 Click [LIVE] and check that continuously snapped images are displayed.

2.2.2 User Frame Setting

Set the user frame which becomes the reference frame for an offset calculation. Set it on the work table as shown in the figure below. For how to set up the user frame, refer to “Know-How: 1 FRAME SETTING.”



Example of user frame setup

Here, set the user frame to UFRAME [1] as described in the figure ‘Example of a 3D single-view fixed frame offset system configuration using fixed camera ’ at the beginning of this section.

2.2.3 3DV Sensor Data Setting

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the fixed camera according to the procedures described in “Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA.”
This system has pre-installed sample 3DV Sensor Data. It is convenient to configure the settings based on the sample. This chapter explains the operations assuming that the sample 3DV Sensor Data will be used.

2.2.4 Tool Frame Setting

Set a tool frame in the center of the end of the gripper claw or the pad to pick up a part. This frame is useful for accurately moving the TCP of the gripper to the part gripping position.
The Z-axis of this frame should be set along the direction in which the gripper approaches the part to be picked up. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure ‘Example of a 3D single-view fixed frame offset system configuration using fixed camera’ at the beginning of this section. For how to set up the tool frame, refer to “Know-How: 1 FRAME SETTING.”

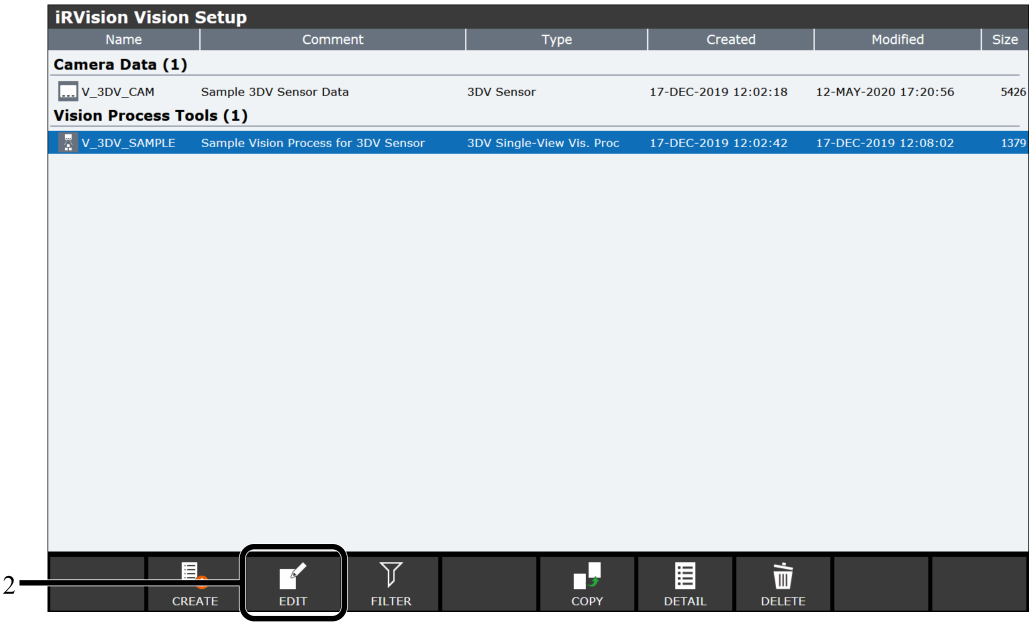
2.2.5 Setting up Vision Process

Set up a “3DV Single-View Vision Process.”
This system has a pre-installed sample vision process. The following explains the procedure for editing the settings based on that sample.

2.2.5.1 Editing vision process

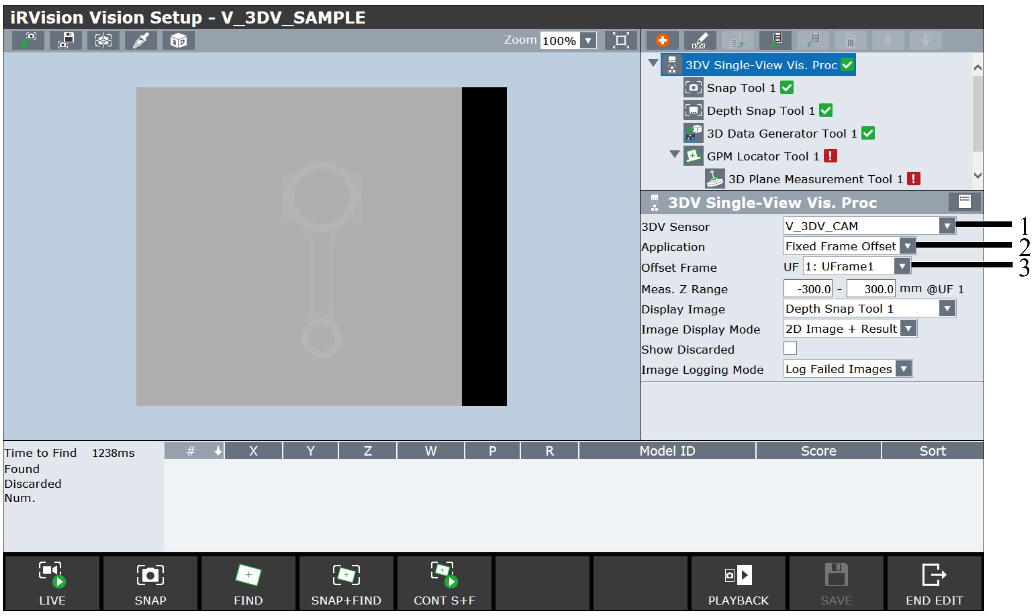
Select the sample vision process and open the edit screen.

1 Click [V_3DV_SAMPLE] in the [Vision Process Tools] category on the vision data list screen.



2 Click [EDIT].
The vision process setup screen appears.

2.2.5.2 Setting parameters of vision process

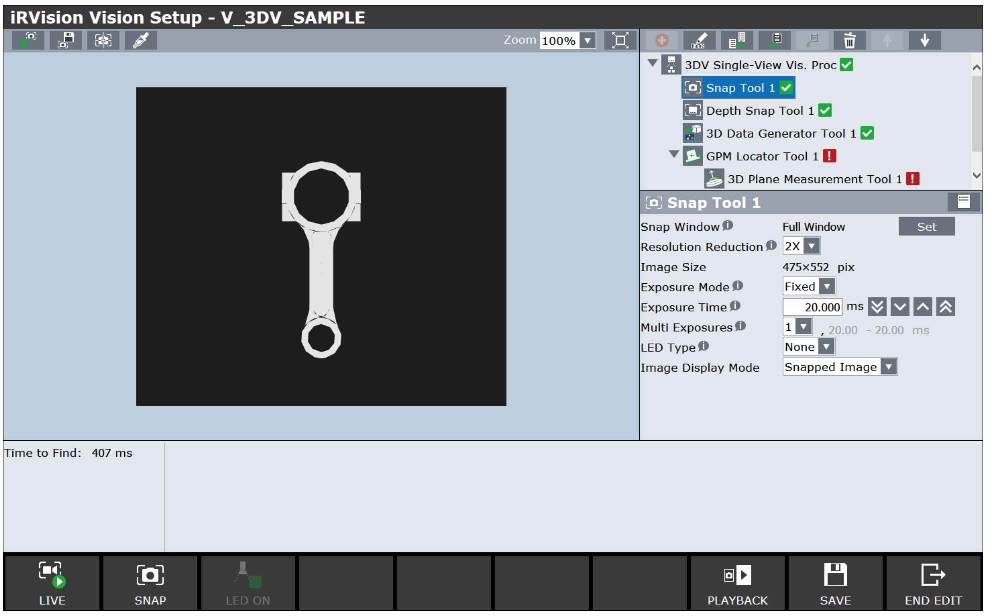


1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 Select [Fixed Frame Offset] from the [Application] drop-down box.
3 Select [1] from the [Offset Frame] drop-down box.
Offset frame is the user frame used for calculation of offset.
Select the user frame number set in “Setup: 2.1.2 User Frame Setting.”
4 Teach the current position as the part detection position in the robot program.
This system comes with the sample TP program for fixed frame offset installed. The details are described in “Setup: 2.2.6 Editing TP Program.” The part measurement position is P[2] on the seventh row in the sample TP program.

2.2.5.3 Teaching Snap Tool

Set parameters for snapping 2D images.

Select [Snap Tool 1] in the tree view to open the snap tool teaching screen. In most cases, you can use the initial settings for the sample as they are. However, if the image is too dark or bright, adjust [Exposure Time] or select [HDR] in [Exposure Mode].
For details on the snap tool, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”

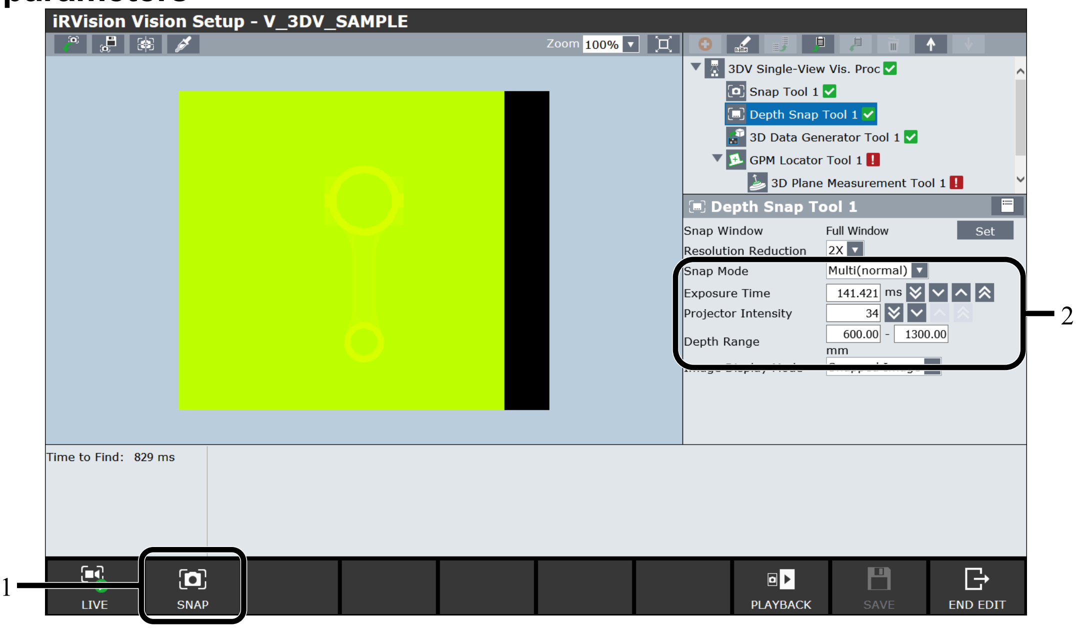


Memo
1 If the image is still too dark even when the exposure time is set to the maximum (200 ms), change [LED Type] to [3DV Sensor] and then adjust the "Exposure Time."
2 The [HDR] option of [Exposure Mode] combines images snapped at multiple exposure times, automatically selected according to the surrounding brightness, into a single image with a wide dynamic range.

2.2.5.4 Teaching Depth Snap Tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



1 Click [SNAP].

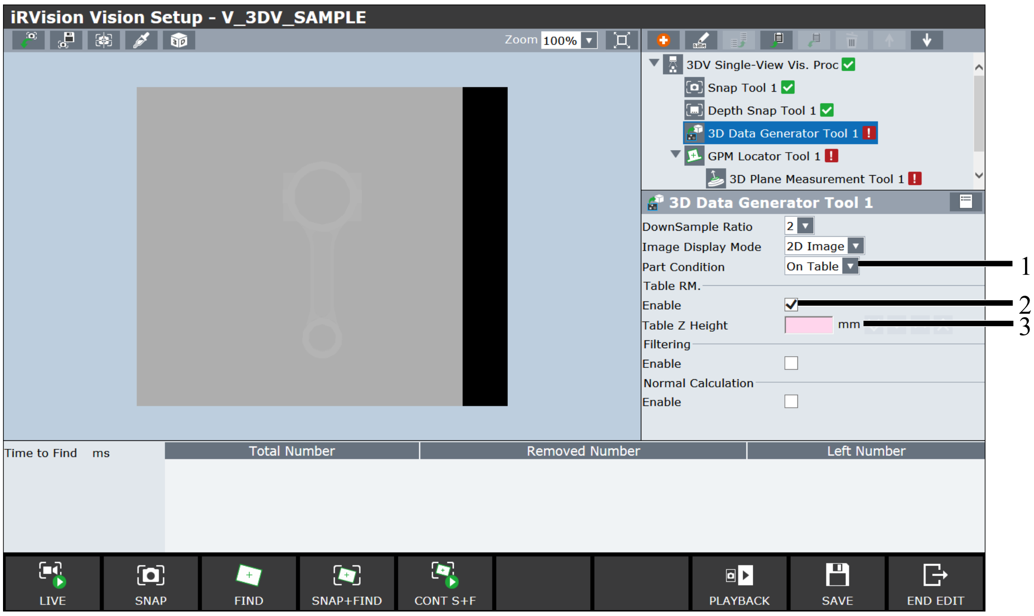
2 Adjust each parameter so that measurement omission (black area) will be reduced.
For details on each parameter, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Repeat the procedure starting from step 1 until the parameters are adjusted appropriately.

> **Memo**
> Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to "Setup: 2.4 3D VISION SENSOR" in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.2.5.5 Setting parameters of 3D Data Generator Tool

Select [3D Data Generator Tool 1] in the tree view, and then set each item.

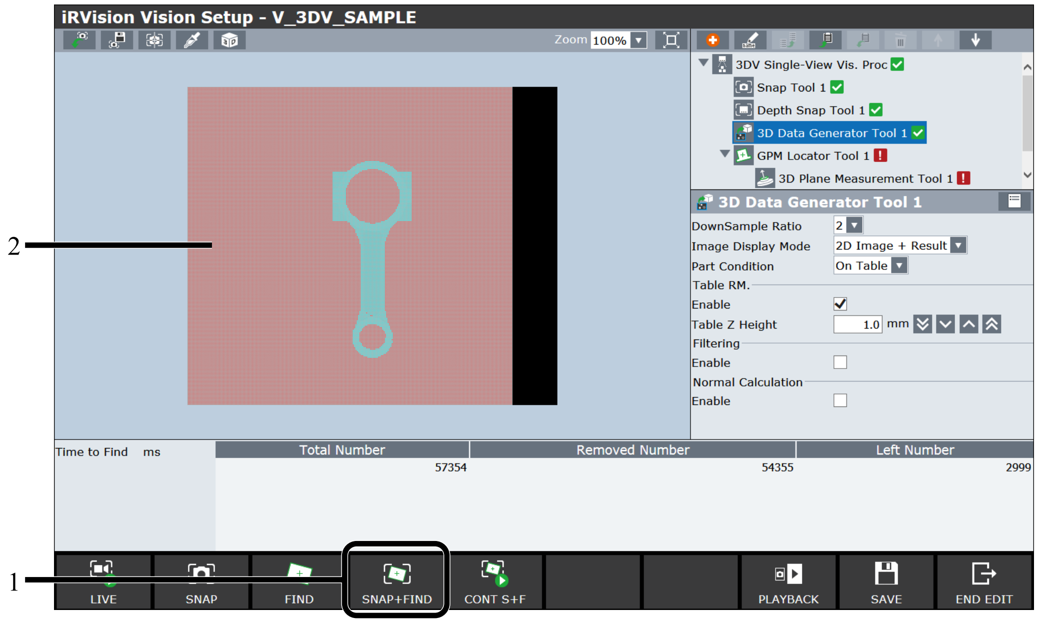
Setting parameters



1 Select [On Table] from the [Part Condition] drop-down box.
2 Check the checkbox of [Enable] in [Table RM].
3 Set [0] for [Table Z Height].
This parameter is the Z height on the camera frame.

Running a test

Check that unnecessary 3D points for part detection have been removed correctly.



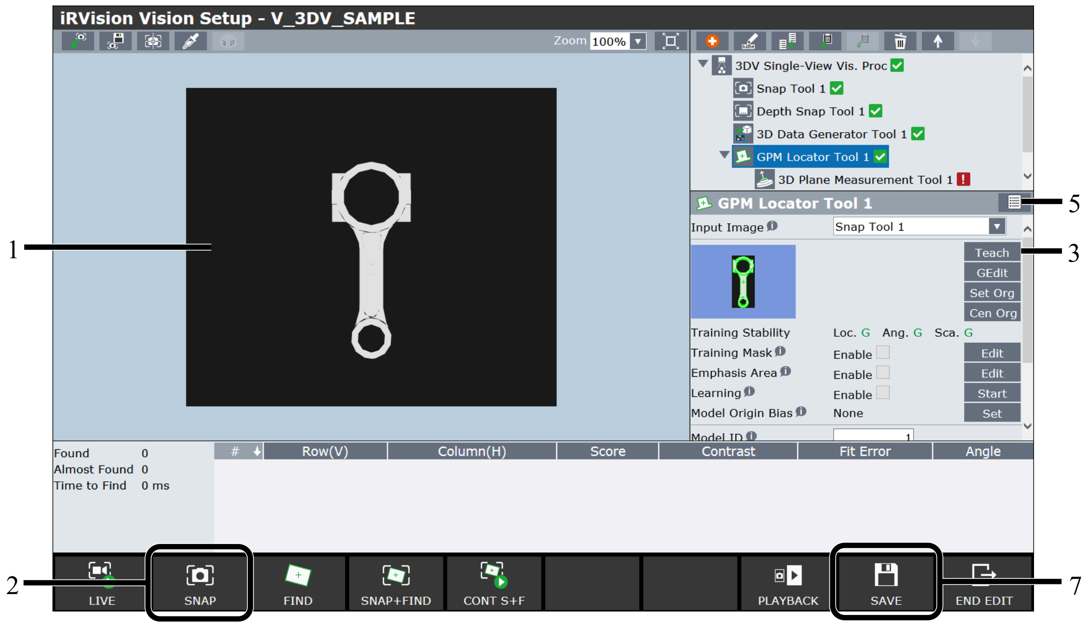
1 Click [SNAP+FIND]. An image is snapped and detection is performed.
2 Check that unnecessary 3D points for part detection have been removed correctly.
The area displayed in red is a removed 3D point group. Check whether the area other than the part is displayed in red.

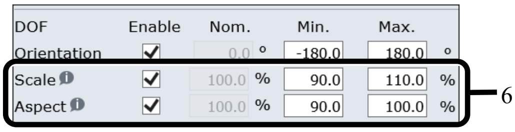
Memo
If the 3D points on the table plane are not removed, fine-tune the "Table Z Height."

2.2.5.6 Teaching GPM Locator Tool

Set parameters for 2D measurement (detection of 2D features).
Select [GPM Locator Tool 1] in the tree view, and then set each item.

Setting parameters





1 Place the part so that it is within the camera view.

2 After determining the measurement position, click [SNAP] to capture an image.

3 Click the [Teach] button to teach the model.
The GPM Locator Tool model setup screen appears. Teach 2D features used for position detection. Select features of the model on the same plane as much as possible to reduce the effects of changes in shape due to parallax. For features that do not need to be included in the model, [Training Mask] can be set to exclude them from the teach model. For details on teaching 2D features, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”

4 Check that the pattern that you want to use as the model has been plotted with a green line and that the model origin (green cross) is on the same plane as the pattern.

> **Memo**
> If the model origin is not on the same plane as the pattern, click the [Set Org.] button and move the model origin onto the same plane as the pattern.
> In the above example, the model origin is changed to be on the plane (large circle of the part) at the highest position of the part.

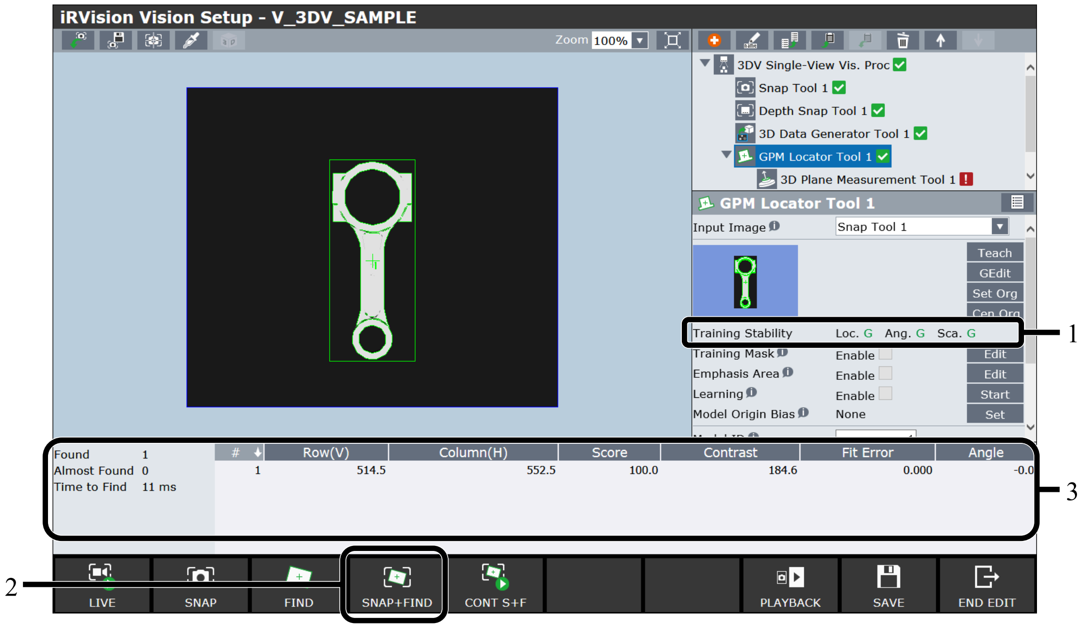
5 Click to switch to advanced mode.

6 Check the checkboxes of [Scale] and [Aspect] in [DOF].

> **Memo**
> Change the [Min.] and [Max.] settings for [Orientation], [Scale], and [Aspect] in [DOF] as necessary. If the distance between the camera and the part varies widely, consider expanding the [Scale] search range setting. If the tilt between the camera and the part varies widely, consider expanding the [Aspect] search range setting. Also, if misdetection of the part seems to increase, consider decreasing the search range parameters. For details, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”

7 Click [SAVE].

Running a test



1 Check [Training Stability]
This item provides a guideline indicating whether the position, angle and size are detected correctly in the taught model. Evaluations are indicated with [G] (good), [P] (poor) and [N] (none). [N] indicates that stable detection of the model may be impossible.
In such a case, change the model, or uncheck [Enable] for the parameter in question in [DOF].

2 Click [SNAP+FIND].
An image is snapped, and detection is performed.

3 Check measurement results.
Check that the same pattern as the model has been plotted with a green line. Then, check the score, contrast, and other results of the detected model on the test result display area. If the score and contrast values are higher than the set thresholds by at least 10 points, there is no problem.

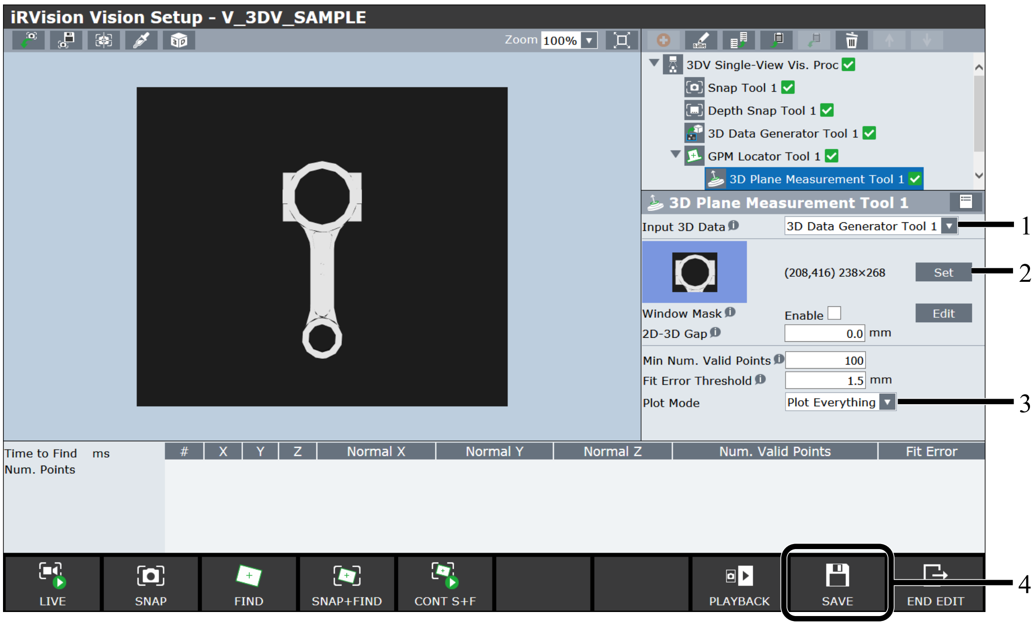
> **Memo**
> Adjust parameters of the GPM Locator Tool if there is a problem. Some parameters are displayed only in the advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

4 Change the part position and repeat the same check several times.

2.2.5.7 Setting up 3D Plane Measurement Tool

Set parameters for detecting the plane near the 2D feature position measured with the GPM Locator Tool from 3D points. Select [3D Plane Measurement Tool 1] in the tree view, and then set each item.

Setting parameters



1 Select [3D Data Generator Tool 1] for [Input 3D data].

2 Click the [Set] button.
The green lines shown in the image are the model and the area taught with pattern matching, and the area inside the red frame is the plane measurement area. When the measurement area is first taught, the red frame will be shown overlapping the green frame, but this can be changed. For details on the measurement area teaching screen for plane measurement, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Once the measurement area has been taught, a thumbnail of the image used for teaching appears, and the position and size of the area appear.

> **Memo**
> If the model origin for the GPM Locator is not in the plane you want to measure, change [2D-3D Gap]. If the model origin is above the Z direction as seen from the plane you want to measure, specify a positive value for this setting. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

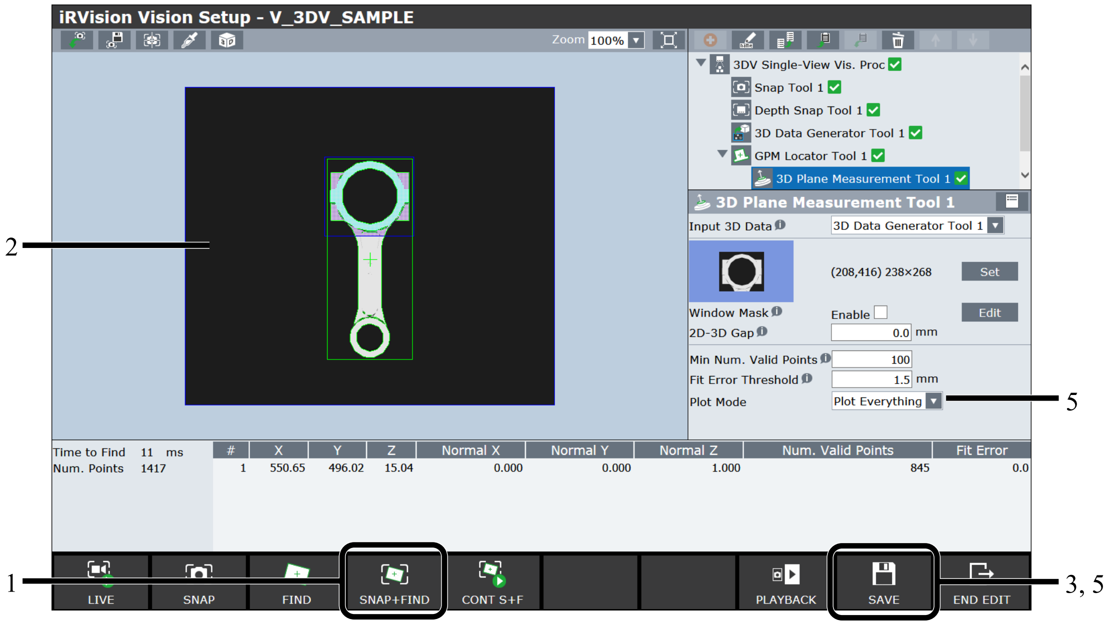
3 Change [Plot Mode] to [Plot Everything].

4 Click [SAVE].

> ⚠ **CAUTION**
> Before setting the 3D Plane Measurement Tool, complete the setting of the GPM Locator Tool. Also, the measurement area must be taught again if the model of the GPM Locator Tool is changed.

Running a test

Check whether the taught area is appropriate. If necessary, adjust parameters to enable stable detection.



1 Click [SNAP+FIND].
  An image is snapped and detection is performed.

2 Check that a light blue plot is displayed on the surface of the part that you want to measure.

> **Memo**
>
> 1 Adjust parameters of the 3D Plane Measurement Tool if there is a problem. For example, if a light blue plot is displayed on a surface other than the one that you want to measure, teach [Window Mask]. Also, some parameters are displayed only in advanced mode. For this reason, switch the mode as necessary. For details, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”
>
> 2 In the above example, the measurement area is taught so that the plane (the large circle section shown on the part) at the highest position of the part will be measured. Change the measurement area according to the shape of the part.

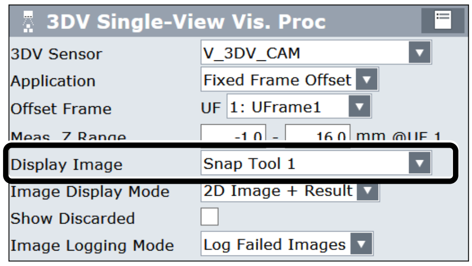
3 Click [SAVE].

4 Repeat steps 1 to 4 by changing the tilt of the plane.

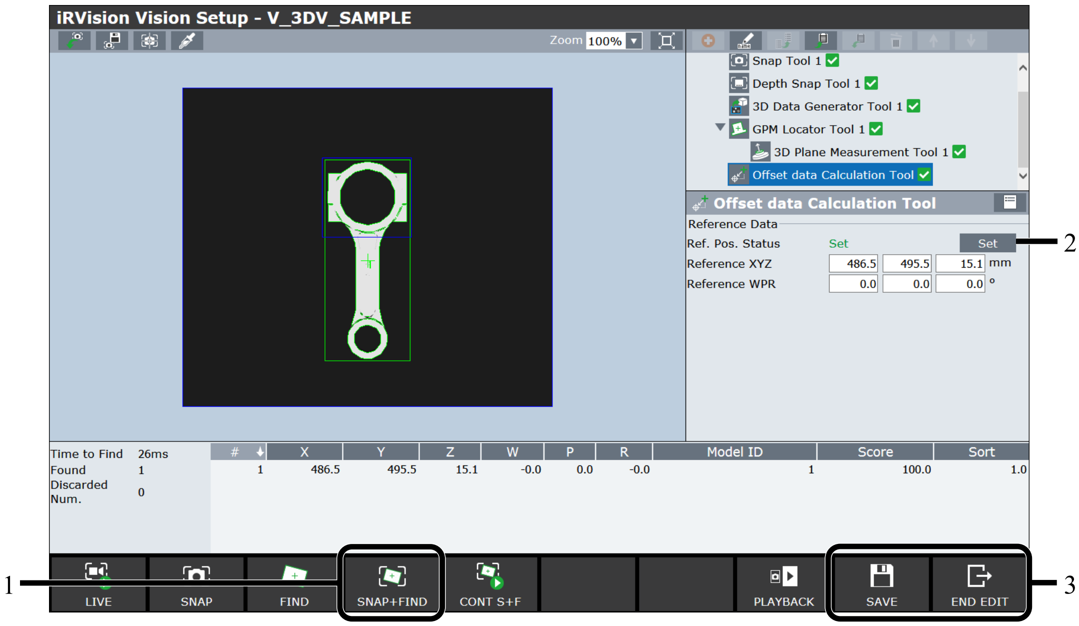
5 If there is no problem with the test run, change the option for [Plot Mode] to [Plot Measurement Area] and click [SAVE] again.

2.2.5.8 Setting reference position

Here, place a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.
In preparation, select [3DV Single-View Vis. Proc] in the tree view, and select [Snap Tool 1] for [Display Image].



Then, select [Offset data Calculation Tool] in the tree view, and then set each item.



1 Click [SNAP+FIND] to find the part.
2 Check that the part has been found correctly, and click the [Set] button of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

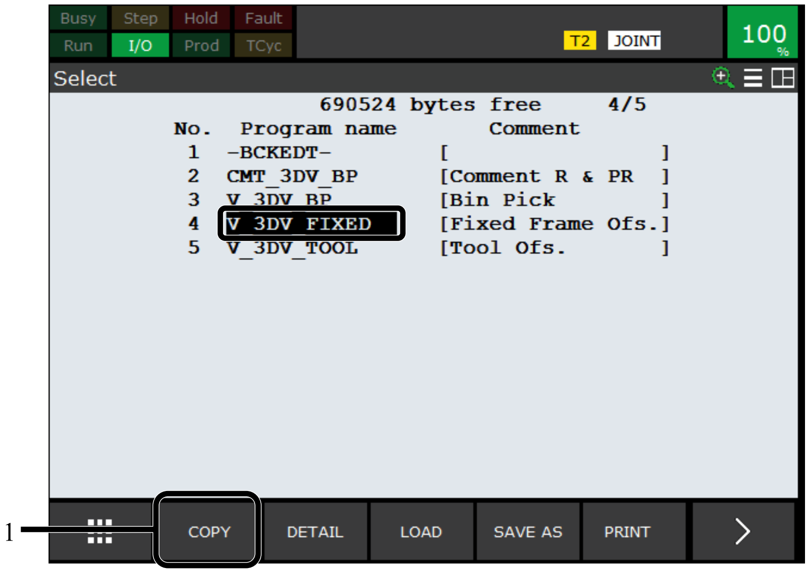
> ⚠ **CAUTION**
> From this point forward, do not move the part until teaching of the robot motion when the part is placed at the reference position is finished in the TP program for fixed frame offset.

2.2.6 Editing TP Program

Edit the TP program for the 3D fixed frame offset system with a 3DV Sensor.
This system has a pre-installed sample program. This section explains how to create a program for transporting a part while actually performing 3D fixed frame offset based on this sample program.

Copying the sample program

1 Select [V_3DV_FIXED] and click [COPY] on the program list screen.



2 Edit the program name and click [OK].

Editing the program

1 Open the copied program and teach the following positions.

Positions

P[1: Home]	Home position. The robot's waiting position and posture when it is not doing anything.
P[2: Search]	The detection position. The robot's position and posture when the sensor has found the part.
P[3: Pick Approach]	The approach position when picking the part. In most cases, it is right above the part that needs to be picked up.
P[4: Pick]	The part pick position. It is the position at which the part is actually picked up (grasped).
P[5: Pick Retract]	The pick retraction position. A relay point when moving from the pick up position to the placement position.
P[6: Place Approach]	The placement approach position.
P[7: Place]	The placement position.
P[8: Place Retract]	The place retraction position. It can be the same position and posture as P[6].

```
UFRAME_NUM=1
UTOOL_NUM=1
J P[1:Home] 30% FINE

!SEARCH
LBL[10]
J P[2:Search] 100% FINE
WAIT    .30(sec)
VISION RUN_FIND 'V_3DV_SAMPLE'
VISION GET_OFFSET 'V_3DV_SAMPLE'
VR[1] JMP LBL[999]

!PICK
L P[3:Pick Approach] 800mm/sec CNT100
VOFFSET,VR[1]
L P[4:Pick] 200mm/sec FINE VOFFSET,VR[1]
!Insert program instructions
!to grasp the part.
CALL ...
L P[5:Pick Retract] 800mm/sec CNT100
VOFFSET,VR[1]

!PLACE
L P[6:Place Approach] 800mm/sec CNT100
L P[7:Place] 200mm/sec FINE
!Insert program instructions
!to release the part.
CALL ...
L P[8:Place Retract] 800mm/sec CNT100
JMP LBL[10]

!ERROR
LBL[999]
```

- UFRAME_NUM=1: Specify the user frame number set in “2.2.2 User Frame Setting”.
- UTOOL_NUM=1: Specify the tool frame number set in “2.2.4 Tool Frame Setting”.
- WAIT .30(sec): Wait for robot-vibration to reduce.
- VISION RUN_FIND: Execute measurement.
- VISION GET_OFFSET: Get the offset data in the measurement result and jump to the last row when not found.
- L P[4:Pick]: Move to the part pick position.
- L P[7:Place]: Move to the part placement position.

2 Specify the instruction to grasp the part and release the part after the P[4] and P[7] motion instructions, respectively, using each of the CALL instructions.

2.2.7 Checking Robot Offset Operation

Check that a part on the table can be detected and picked up accurately.
Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

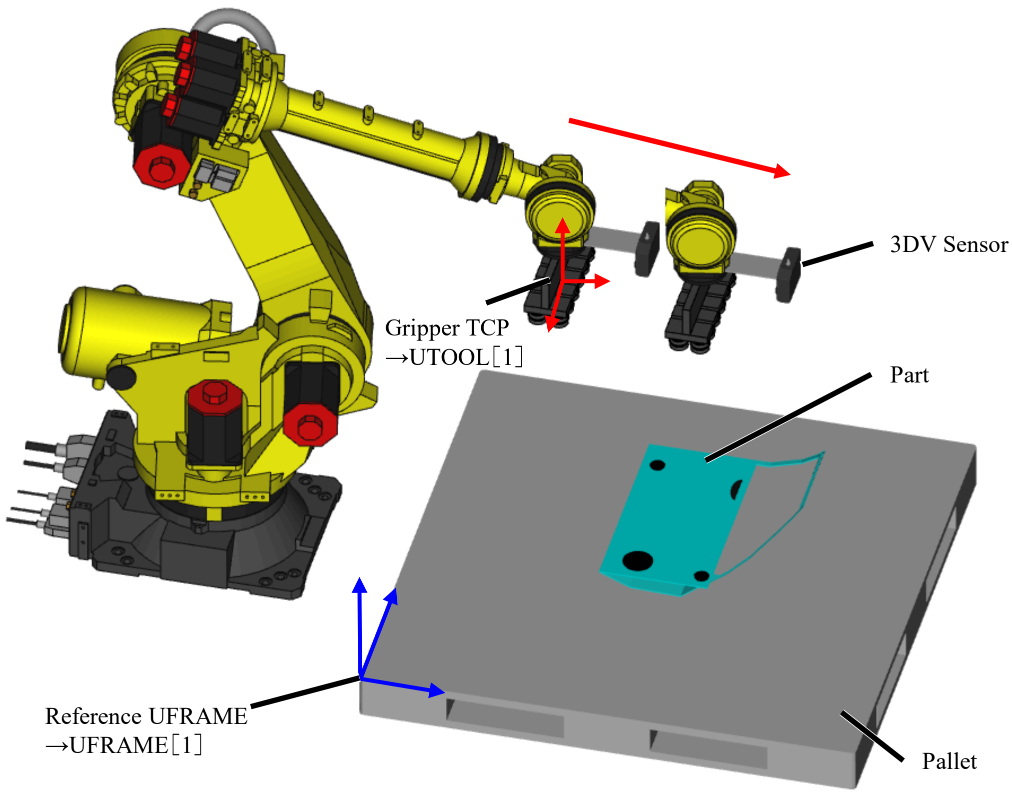
- Place the part near the reference position, find it and check that it can be picked up accurately. If the accuracy of compensation is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation, find it and check that it can be picked up accurately.
- Rotate the part, find it and check that it can be picked up accurately. If the part near the reference position can be picked up accurately but the accuracy decreases as the part rotates, the settings of the calibration grid and of the frame used for offset may not have been performed accurately. If you set the frame with a pointer tool, check the accuracy of touch-up and retry calibrating the 3DV Sensor.
- Change the part’s height, find it and check that it can be picked up accurately.
- Tilt the part, find it and check that it can be picked up accurately.

2.3 3D MULTI-VIEW FIXED FRAME OFFSET SYSTEM USING ROBOT-MOUNTED CAMERA

When 3D fixed frame offset is used with a large part that does not fit within the 3DV Sensor's field of view, this function can be used to perform fixed frame offset with a greater precision than measuring one location. This section explains the setup procedures for the 3D fixed frame offset system using one robot-mounted camera to measure multiple locations.

Memo

With this system, measurement is performed at multiple measurement points. The offset precision is improved by selecting measurement points that are as far apart as possible, so a robot-mounted camera is suitable for measurement. It is possible to measure at multiple points with a fixed camera, but measuring with multiple cameras is preferable.
It is also possible to use multiple robot-mounted cameras or to use a combination of robot-mounted and fixed cameras.



Example of a 3D multi-view fixed frame offset system configuration using a robot-mounted camera

2.3.1 Installation and Connection of 3DV Sensor

Installation of the 3DV Sensor

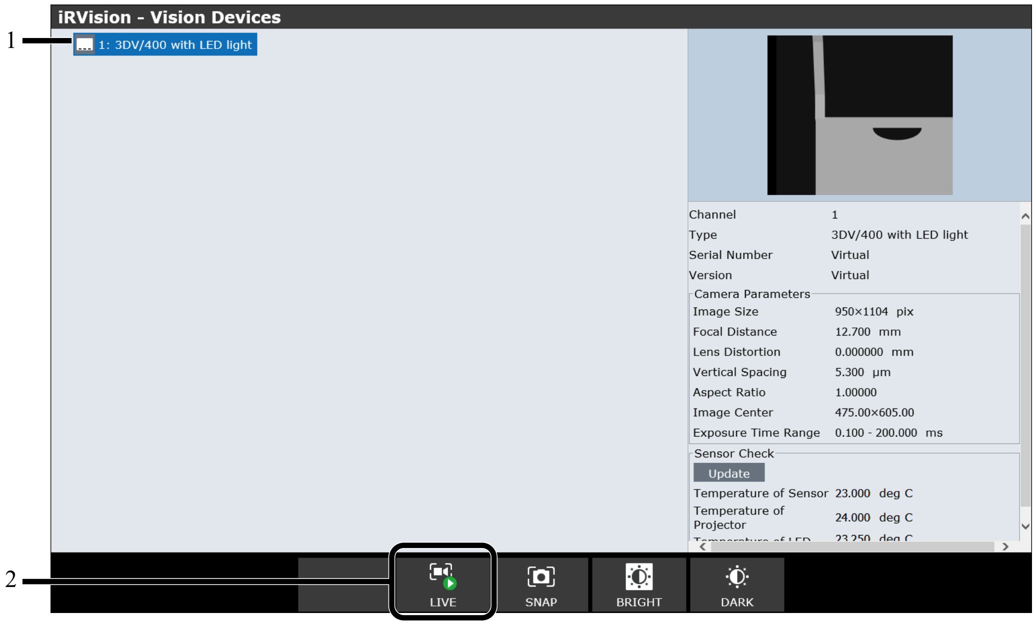
Install the 3DV Sensor on the robot.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

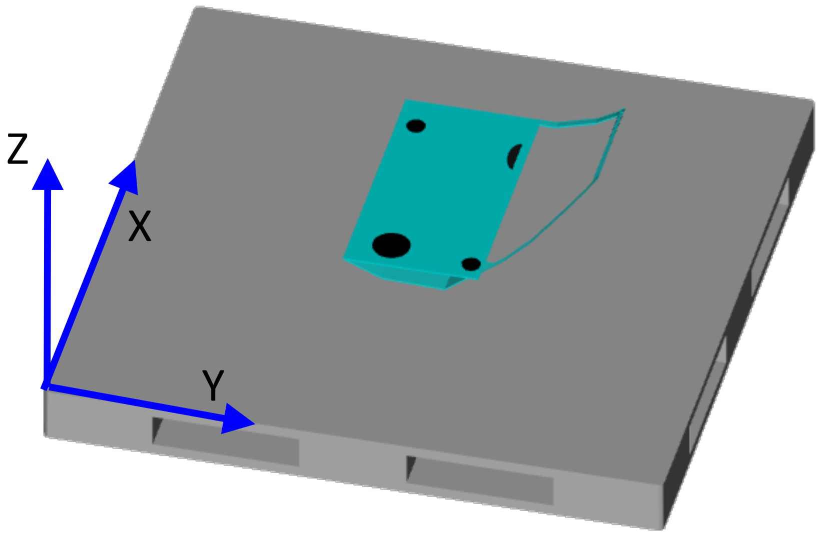
Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.



1 On the ROBOT Homepage, select [iRVision] → [Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.
2 Click [LIVE] and check that continuously snapped images are displayed.

2.3.2 User Frame Setting

Set the user frame which becomes the reference frame for an offset calculation. Set it on the work table as shown in the figure below. For how to set up the user frame, refer to “Know-How: 1 FRAME SETTING”.



Example of user frame setup

Here, set the user frame to UFRAME [1] as described in the figure ‘Example of a 3D multi-view fixed frame offset system configuration using a robot-mounted camera’ at the beginning of this section.

2.3.3 3DV Sensor Data Setting

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the robot-mounted camera according to the procedures described in "Know-How: 2.1 3DV SENSOR MOUNTING POSITION SETUP WITH ROBOT-MOUNTED CAMERA."
This system has pre-installed sample 3DV Sensor Data. It is convenient to configure the settings based on the sample. This chapter explains the operations assuming that the sample 3DV Sensor Data will be used.

2.3.4 Tool Frame Setting

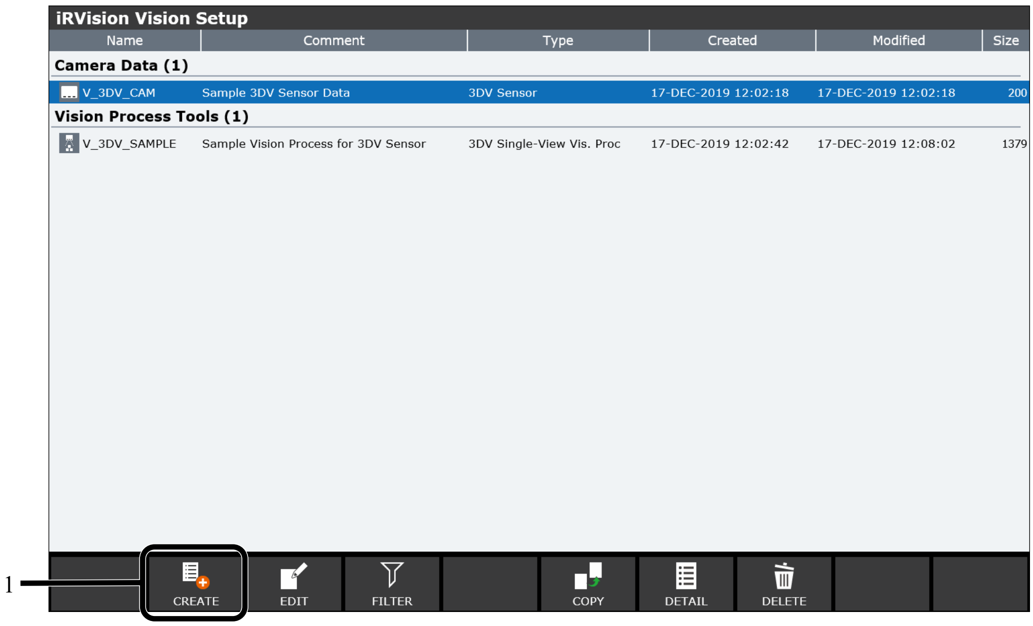
Set a tool frame in the center of the end of the gripper claw or the pad to pick up a part. This frame is useful for accurately moving the TCP of the gripper to the part gripping position.
The Z-axis of this frame should be set along the direction in which the gripper approaches the part to be picked up. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure 'Example of a 3D multi-view fixed frame offset system configuration using a robot-mounted camera' at the beginning of this section. For how to set up the tool frame, refer to "Know-How: 1 FRAME SETTING."

2.3.5 Creating and Setting up Vision Process

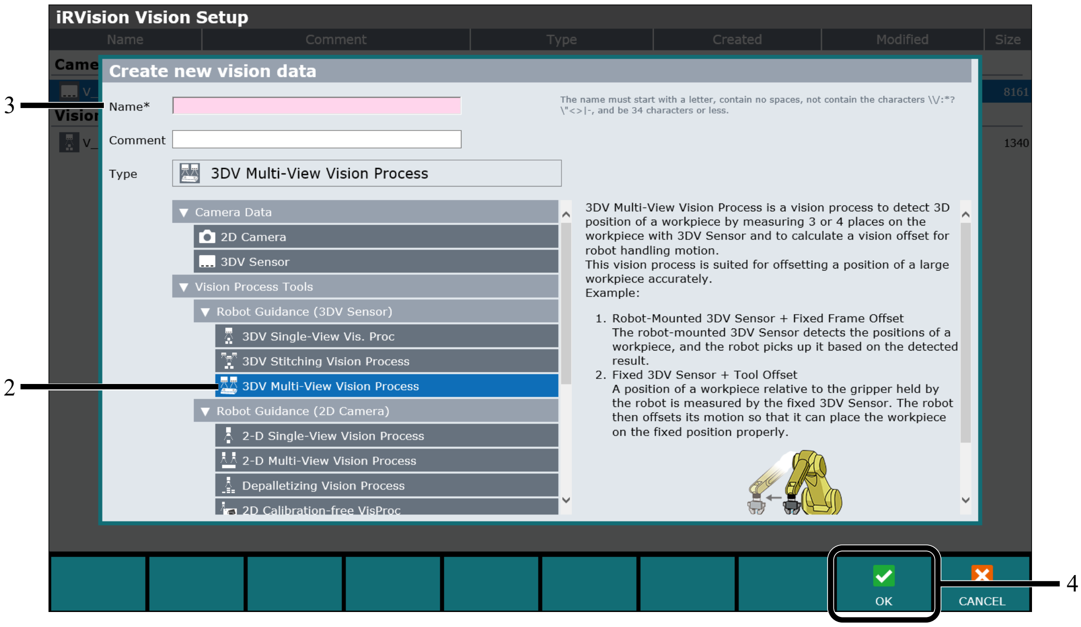
Create and set up a new "3DV Multi-View Vision Process" program.

2.3.5.1 Creating a new vision process

Create a vision process with the following procedure.



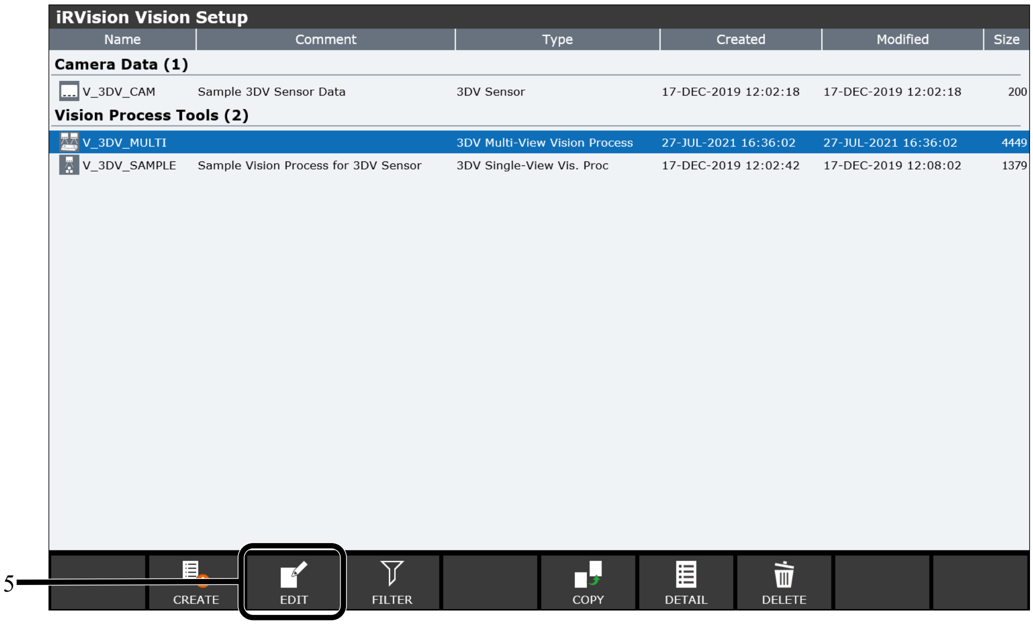
1 Click [CREATE].
A pop-up is displayed for creating new vision data.



2 Select [3DV Multi-View Vision Process].

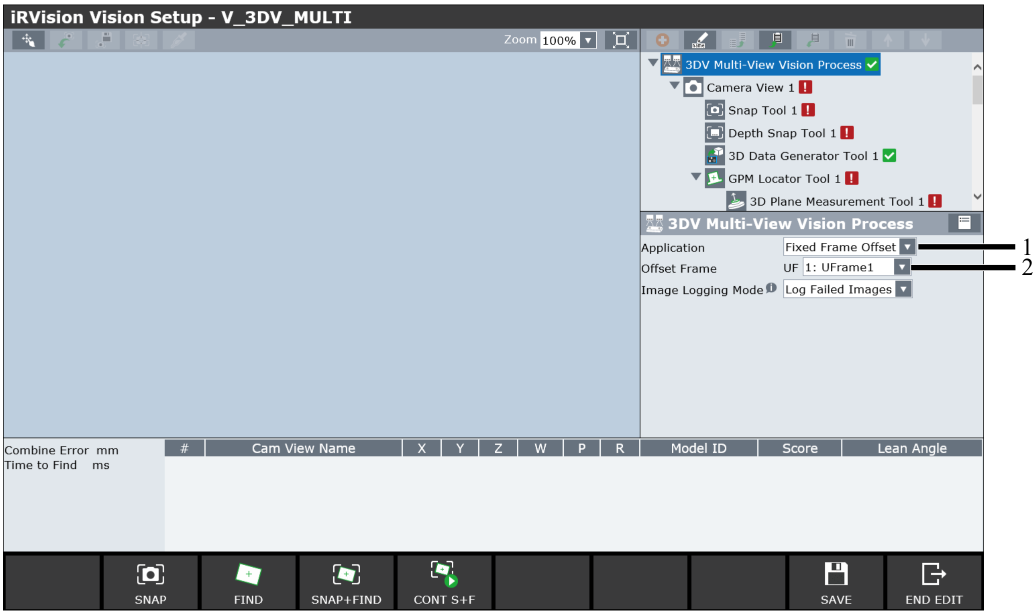
3 Enter a program name in [Name].
Give the program a unique name.

4 Click [OK].
A new program is created.



5 Click [EDIT].
The vision process setup screen appears.

2.3.5.2 Setting parameters of vision process



1 Select [Fixed Frame Offset] from the [Application] drop-down box.
2 Select [1] from the [Offset Frame] drop-down box.
Offset frame is the user frame used for calculation of offset.
Select the user frame number set in “Setup: 2.3.2 User Frame Setting.”

Memo
If you click [icon] to switch to advanced mode, you can enable/disable [Camera Base Find]. When the checkbox of [Camera Base Find] is checked, a part is found based on the frame of the 3DV Sensor. When mounting the sensor to the robot, the sensor snap position changes according to the movement of the robot. For this reason, you should normally enable [Camera Base Find] to find a part. Also, with “3DV Multi-View Vision Process”, multiple camera views must be set up. If [Camera Base Find] is enabled, the detection position of all camera views is the position based on the 3DV Sensor’s frame.

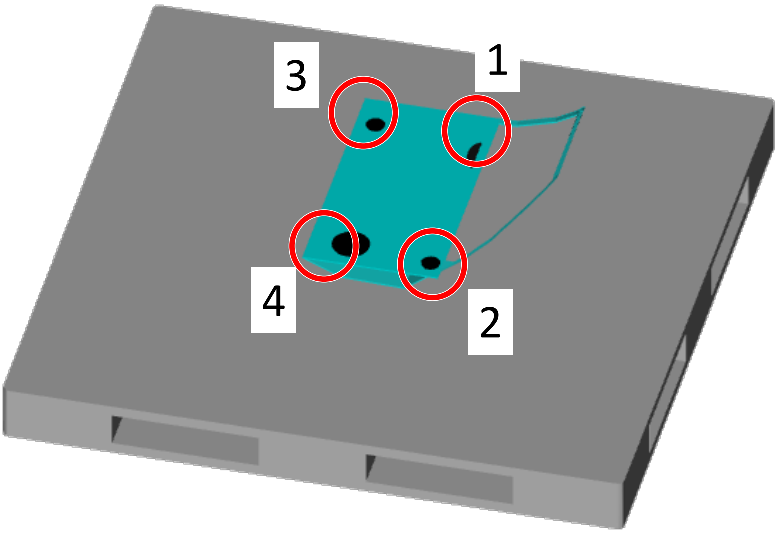
2.3.5.3 Determining measurement point for each camera view

In the following procedures, the measurement points for the camera views will be set up. Before the setup, you must first roughly determine which parts of the work to measure.

Determine the measurement points with the camera views arranged as follows.

- The camera views are separated as much as possible.
- The camera views are not all arranged in a straight line.
- To the extent possible, each camera view is set up to measure a different measurement surface. Measurement surfaces are set in “Setup: 2.3.5.9 Setting up 3D Plane Measurement Tool”, and it is preferable to set a different plane for each camera view.
- Each camera view includes model features and a wide plane. Model features are taught in “Setup: 2.3.5.8 Teaching GPM Locator Tool”, and wide planes are set as measurement surfaces in “Setup: 2.3.5.9 Setting up 3D Plane Measurement Tool.” Accuracy is improved by setting measurement points in a way that both of these fit in the camera view.

In this section, the camera views are set up with the measurement points near the red circles in the figure below. The numbers indicate the camera view numbers.



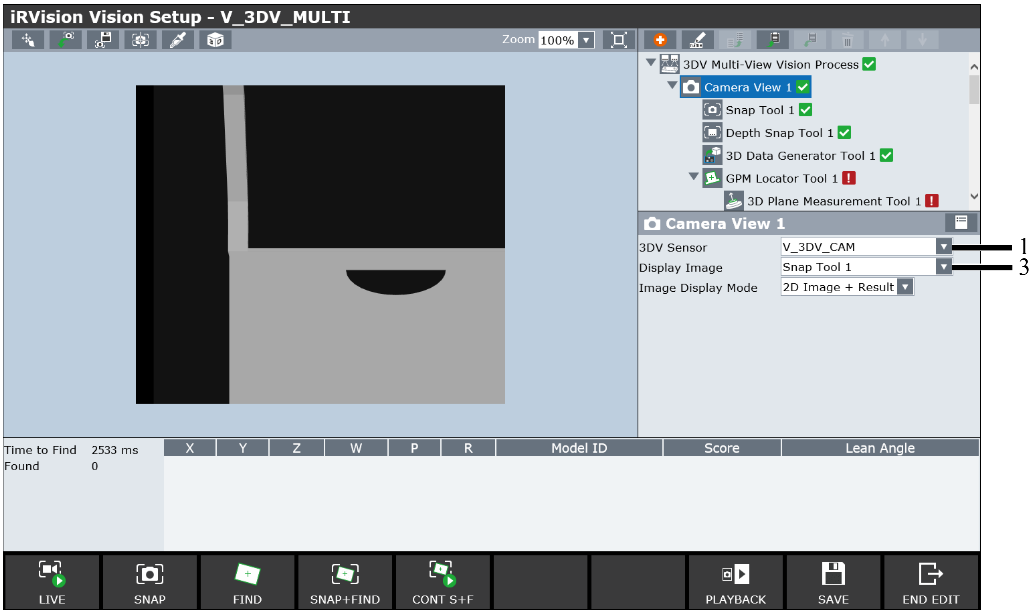
Determining the measurement points

2.3.5.4 Setting up Camera View 1

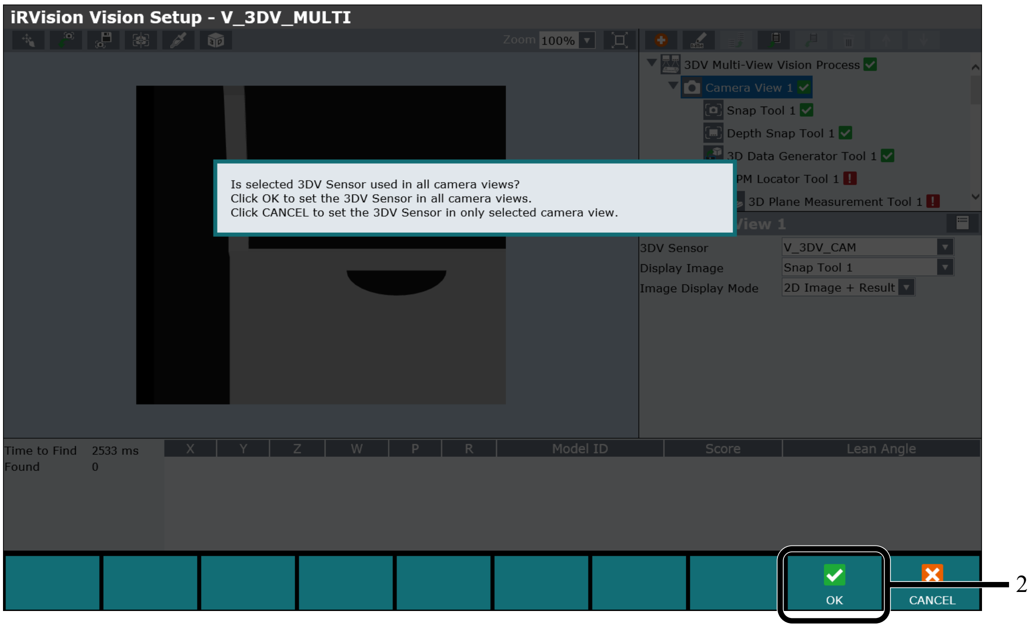
Set up the 3DV Sensor to use for Camera View 1.

2

Setting parameters



1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 When you select [3DV Sensor], the following message appears. Here, click [OK] to use the same camera data in other camera views.



3 Select [Snap Tool 1] from the [Display Image] drop-down box.
4 Jog the robot so that the feature on the part that you want to measure with Camera View 1 is near the center of the 3DV Sensor's field of view to determine the detection position.

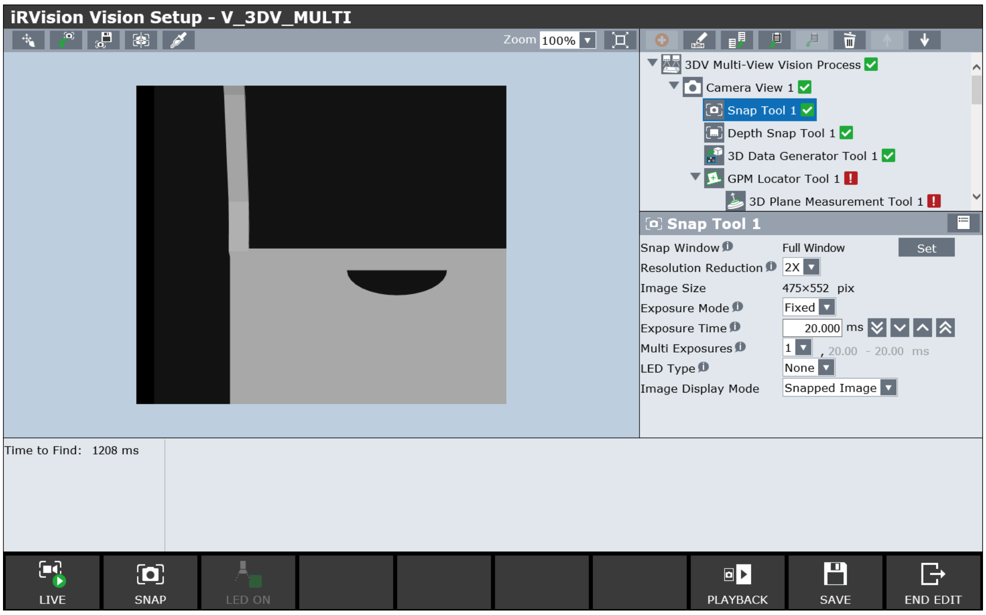
Memo

Once the detection position is determined, it is convenient to store the position in a position register.
For details about setting up the position registers and an example TP program, refer to “Setup: 2.3.6 Creating and Teaching a TP Program.”

2.3.5.5 Teaching Snap Tool

Set parameters for snapping 2D images.

Select [Snap Tool 1] in the tree view to open the snap tool teaching screen. In most cases, you can use the initial settings for the sample as they are. However, if the image is too dark or bright, adjust [Exposure Time] or select [HDR] in [Exposure Mode].
For details on the snap tool, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”



Memo

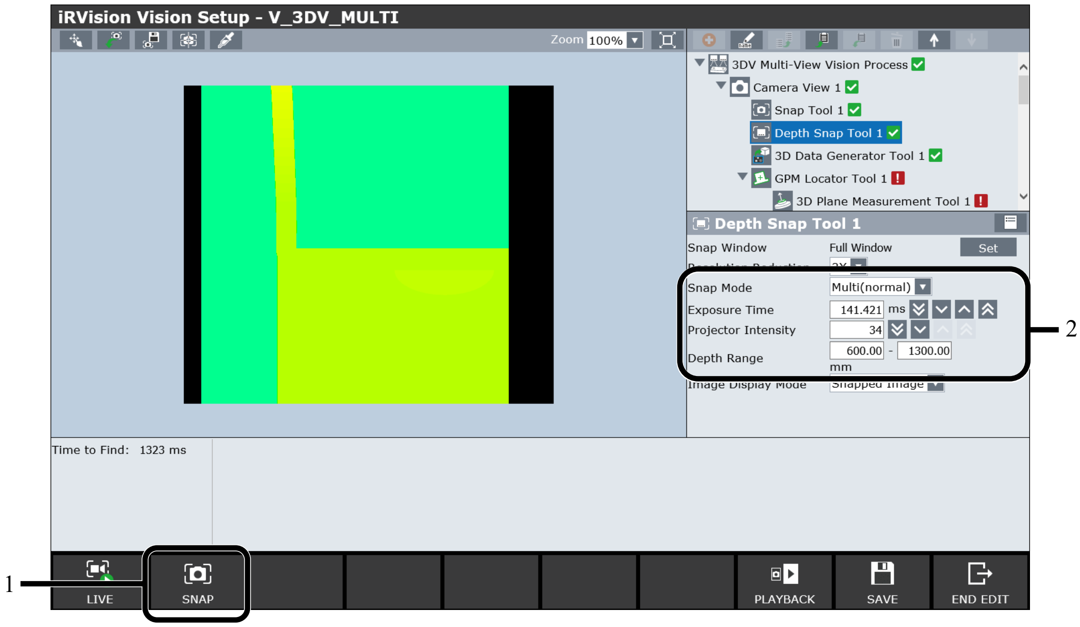
1 If the image is still too dark even when the exposure time is set to the maximum (200 ms), change [LED Type] to [3DV Sensor] and then adjust the “Exposure Time.”

2 The [HDR] option of [Exposure Mode] combines images snapped at multiple exposure times, automatically selected according to the surrounding brightness, into a single image with a wide dynamic range.

2.3.5.6 Teaching Depth Snap tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



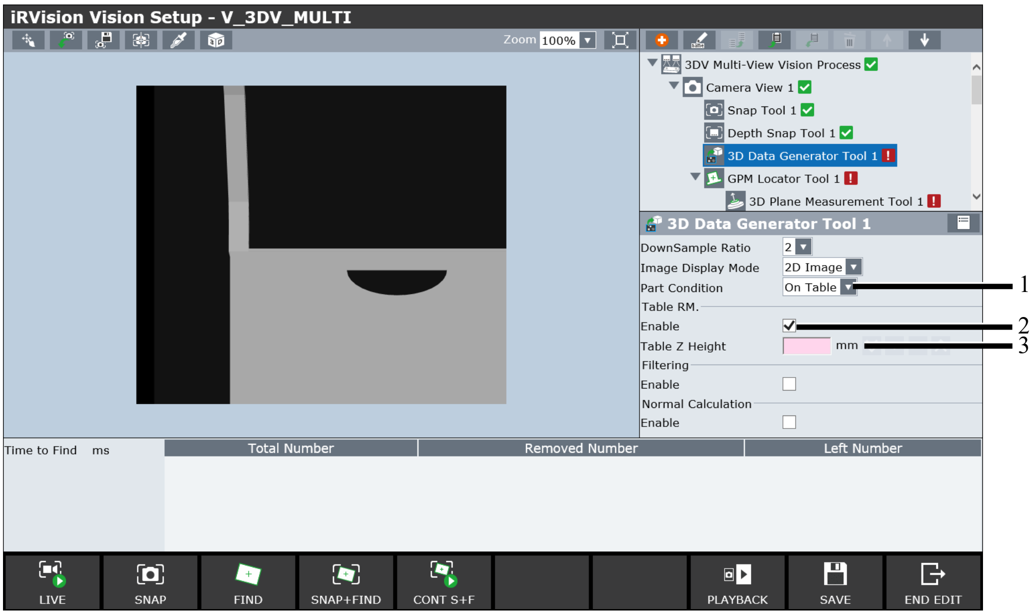
1 Click [SNAP].
2 Adjust each parameter so that measurement omission (black area) will be reduced.
For details on each parameter, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Repeat the procedure starting from step 1 until the parameters are adjusted appropriately.

> **Memo**
> Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to "Setup: 2.4 3DV SENSOR" in "iRVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.3.5.7 Setting parameters of 3D Data Generator Tool

Select [3D Data Generator Tool 1] in the tree view, and then set each item.

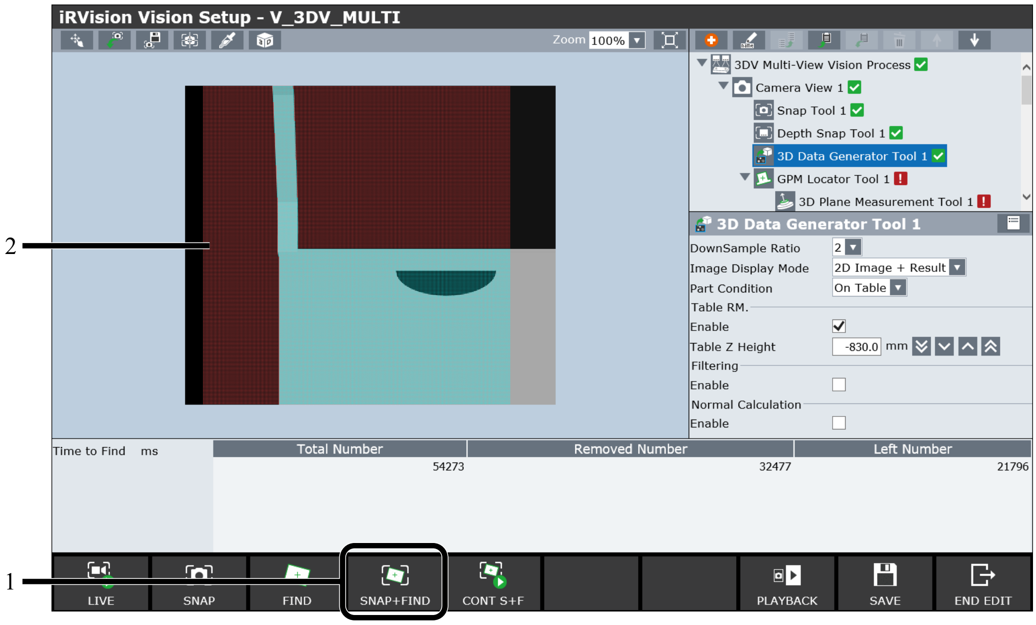
Setting parameters



1 Select [On Table] from the [Part Condition] drop-down box.
2 Check the checkbox of [Enable] in [Table RM.].
3 Set [Table Z Height].
This parameter is the height from the 3DV Sensor to the offset plane, which is normally a negative value. It represents the Z height on the camera frame.

Running a test

Check that unnecessary 3D points for part detection have been removed correctly.



1 Click [SNAP+FIND]. An image is snapped and detection is performed.

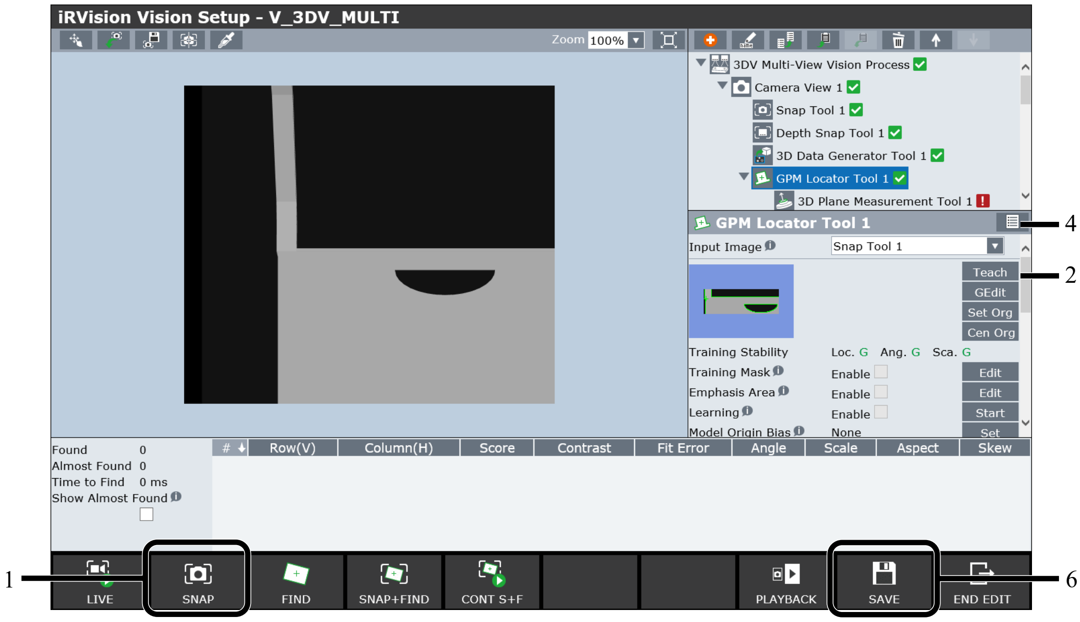
2 Check that unnecessary 3D points for part detection have been removed correctly.
The area displayed in red is a removed 3D point group. Check whether the area other than the part is displayed in red.

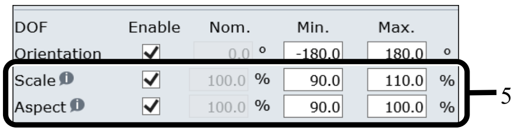
> **Memo**
> If the 3D points on the table plane are not removed, fine-tune the "Table Z Height."

2.3.5.8 Teaching GPM Locator Tool

Set parameters for 2D measurement (detection of 2D features).
Select [GPM Locator Tool 1] in the tree view, and then set each item.

Setting parameters





DOF	Enable	Nom.		Min.	Max.	
Orientation	✓	0.0	°	-180.0	180.0	°
Scale	✓	100.0	%	90.0	110.0	%
Aspect	✓	100.0	%	90.0	100.0	%

1 Click [SNAP] to capture an image.
2 Click the [Teach] button to teach the model
The GPM Locator Tool model setup screen appears. Teach 2D features used for position detection. Select features of the model on the same plane as much as possible to reduce the effects of changes in shape due to parallax. For features that do not need to be included in the model, [Training Mask] can be set to exclude them from the teach model. For details on teaching 2D features, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
3 Check that the pattern that you want to use as the model has been plotted with a green line and that the model origin (green cross) is on the plane of the pattern.

> **Memo**
> If the model origin is not on the same plane as the pattern, click the [Set Org.] button and move the model origin onto the same plane as the pattern.

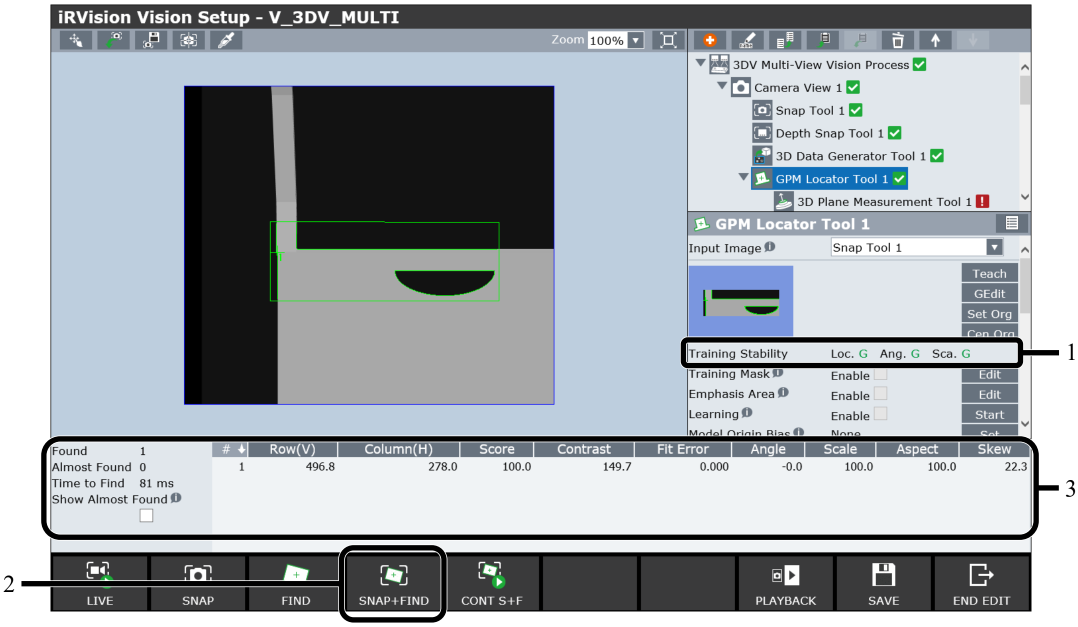
4 Click [icon] to switch to advanced mode.

5 Check the checkboxes of [Scale] and [Aspect] in [DOF].

Memo
Change the [Min.] and [Max.] settings for [Orientation], [Scale], and [Aspect] in [DOF] as necessary. If the distance between the camera and the part varies widely, consider expanding the [Scale] search range setting. If the tilt between the camera and the part varies widely, consider expanding the [Aspect] search range setting. Also, if misdetection of the part seems to increase, consider decreasing the search range parameters. For details, see "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

6 Click [SAVE].

Running a test



1 Check [Training Stability].
This item provides a guideline indicating whether the position, angle and size are detected correctly in the taught model. Evaluations are indicated with [G] (good), [P] (poor) and [N] (none). [N] indicates that stable detection of the model may be impossible.
In such a case, change the model, or uncheck [Enable] for the parameter in question in [DOF].

2 Click [SNAP+FIND].
An image is snapped, and detection is performed.

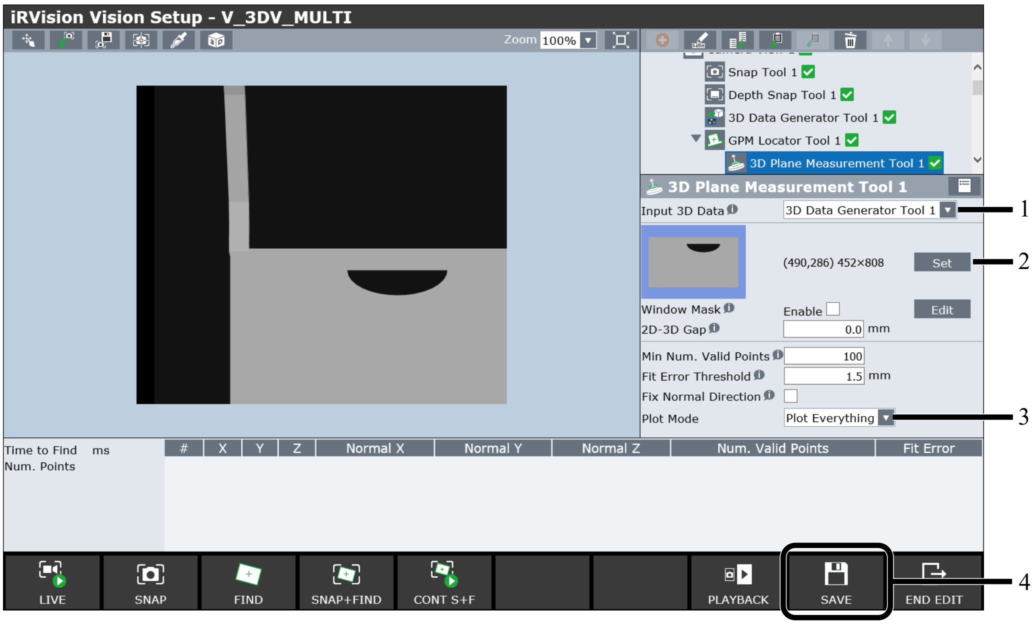
3 Check measurement results.
Check that the same pattern as the model has been plotted with a green line. Then, check the score, contrast, and other results of the detected model on the test result display area. If the score and contrast values are higher than the set thresholds by at least 10 points, there is no problem.

Memo
Adjust parameters of the GPM Locator Tool if there is a problem. Some parameters are displayed only in the advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.3.5.9 Setting up 3D Plane Measurement Tool

Set parameters for detecting the plane near the 2D feature position detected with the GPM Locator Tool from 3D snap data. Select [3D Plane Measurement Tool 1] in the tree view, and then set each item.

Setting parameters



1 Select [3D Data Generator Tool 1] for [Input 3D data].
2 Click the [Set] button.
The green lines shown in the image are the model and the area taught with pattern matching, and the area inside the red frame is the plane measurement area. When the measurement area is first taught, the red frame will be shown overlapping the green frame, but this can be changed. For details on the measurement area teaching screen for plane measurement, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Once the measurement area has been taught, a thumbnail of the image used for teaching appears, and the position and size of the area appear.

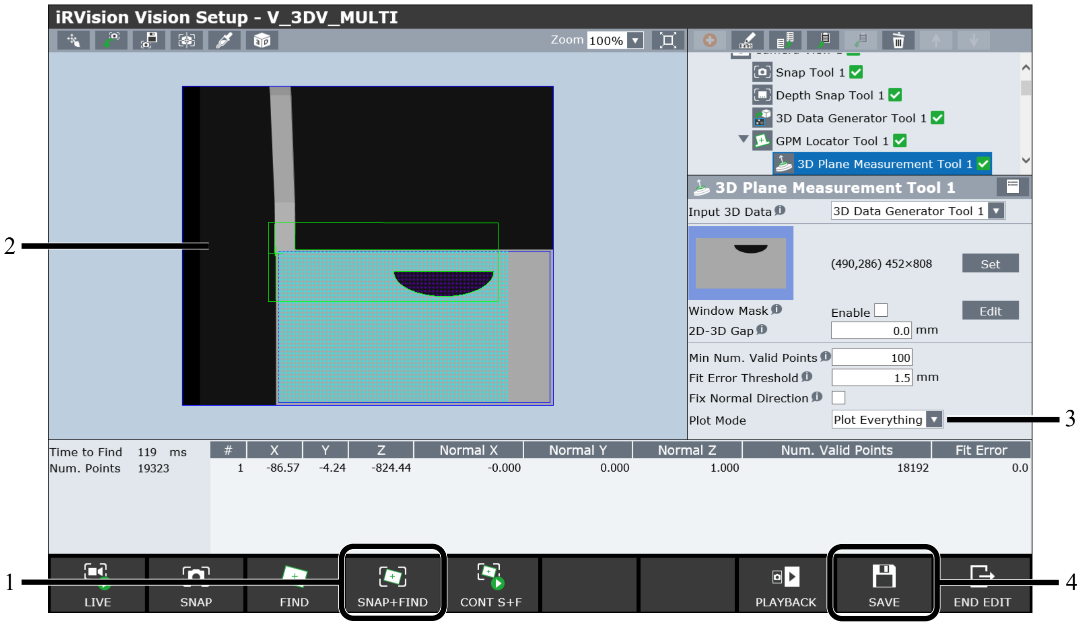
Memo
If the model origin for pattern matching is not in the plane you want to measure, change [2D-3D Gap]. If the model origin is above the Z direction as seen from the plane you want to measure, specify a positive value for this setting. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3 Select [Plot Everything] from the [Plot Mode] drop-down box.
4 Click [SAVE].

⚠ CAUTION
Before setting the 3D Plane Measurement Tool, complete the setting of the GPM Locator Tool. Also, the measurement area must be taught again if the model of the GPM Locator Tool is changed.

Running a test

Check whether the taught area is appropriate. If necessary, adjust parameters to enable stable detection.



1 Click [SNAP+FIND].
An image is snapped and detection is performed.
2 Check that a light blue plot is displayed on the surface of the part that you want to measure.

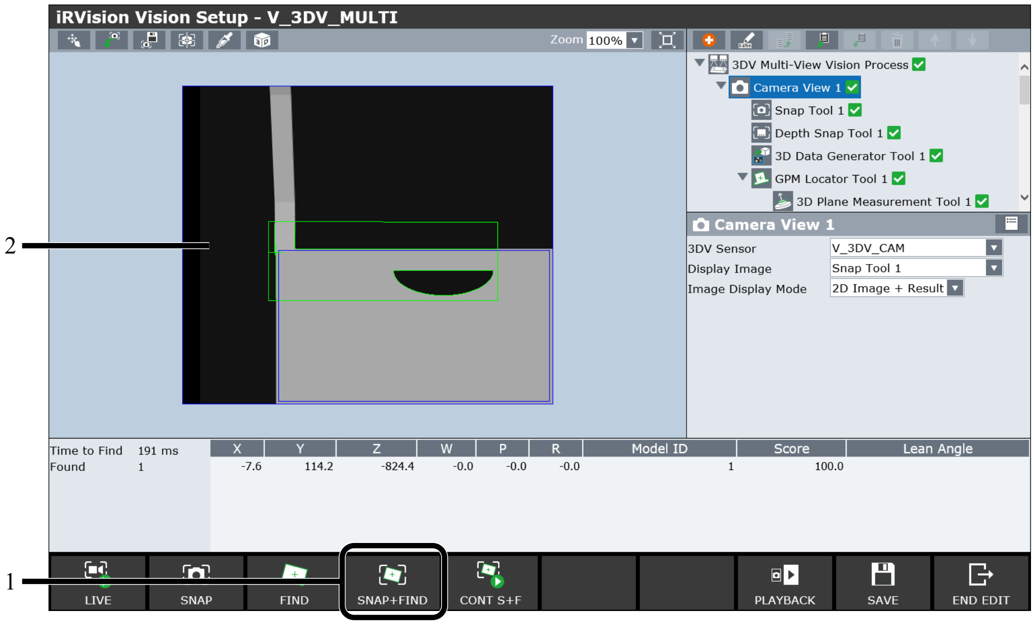
Memo

1 Adjust parameters of the 3D Plane Measurement Tool if there is a problem. For example, if a light blue plot is displayed on a surface other than the one that you want to measure, teach [Window Mask]. Also, some parameters are displayed only in advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
2 Change the measurement area according to the shape of the part.

3 If there is no problem with the test run, change the option for [Plot Mode] to [Plot Measurement Area].
4 Click [SAVE].

2.3.5.10 Running a test for Camera View 1

After setting all child tools for Camera View 1, select [Camera View 1] in the tree view, and then perform a test run to check whether detection with Camera View 1 is performed correctly.



1 Click [SNAP+FIND].
An image is snapped and detection is performed.
2 Check whether detection was successful.
If the features you want to detect on the screen are plotted with a green line, detection completed without problems.

> ⚠ **CAUTION**
> From this point forward, do not move the part until teaching of the robot motion when the part is placed at the reference position is finished in the TP program for fixed frame offset.

> **Memo**
> 1 The reference position in “3DV Multi-View Vision Process” in “Setup: 2.3.5.12 Setting Reference Position” is set using the detection results from the camera views. Therefore, if detection with the camera view is not successful, vision process setup is not complete.
> If detection with the camera view is unsuccessful, review the parameter settings of the child tools, and check whether the detection is performed correctly again.
> 2 The value for [Lean angle] is not displayed in the result display area at this stage. It will be displayed after the reference position is set in “Setup: 2.3.5.12 Setting Reference Position.”

2.3.5.11 Setting up Camera Views 2 to 4

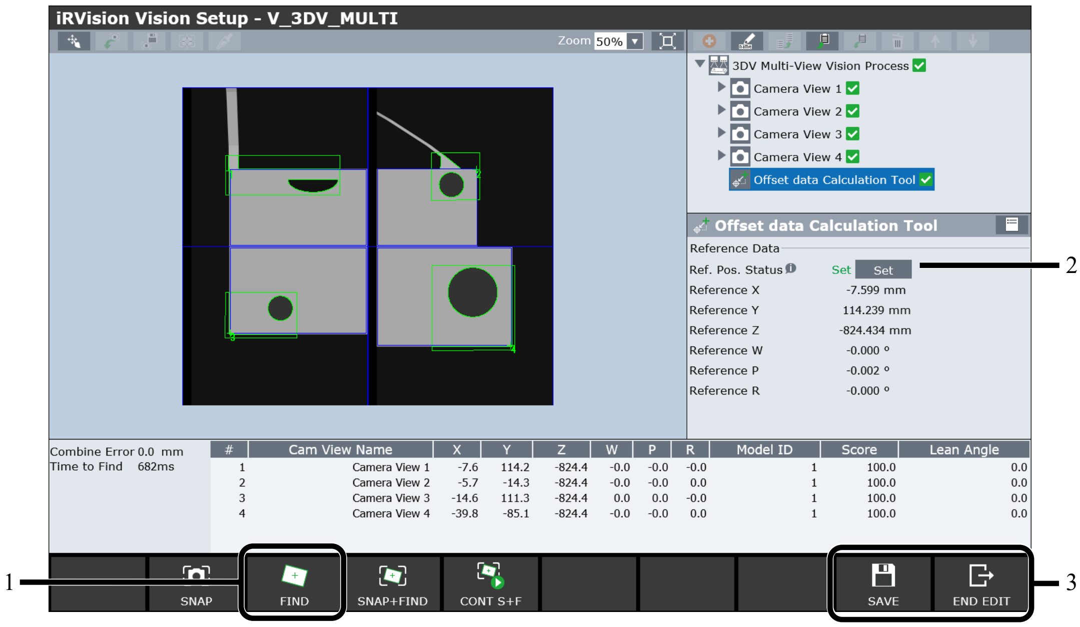
After setting up Camera View 1, set up Camera Views 2 to 4 using the same procedures.
The procedures are the same, but it is recommended that you move the robot and change the measurement position for each camera view. This is because the accuracy of the offset motion is improved by separating the part teaching positions as much as possible for each camera views.

> **Memo**
> 1 When storing the camera view detection position in a position register, it is convenient to store each camera view's position in a different position register. If you are creating a TP program based on the example in "Setup: 2.3.6 Creating and Teaching a TP Program", set up the position registers based on the setting example too.
> 2 In the initial state, four camera views are available on the assumption that four points will be measured, but if it is impractical to measure four points, you can delete one of the camera views. However, Camera View 1 cannot be deleted.
> 3 When setting up Camera Views 2 to 4, snap after you have moved the robot to each of the measurement positions. Be careful not to continue setup with the same image snapped from another camera view.

2.3.5.12 Setting reference position

Here, place a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.

Select [Offset data Calculation Tool] in the tree view, and then set each item.



1 Click [FIND] to detect the part.

> ⚠ **CAUTION**
> Do not click [SNAP] or [SNAP+FIND] at this point. If you take a snap, the images snapped at the current position is reflected in all camera views, and the reference position will not be set correctly.
> If you mistakenly click [SNAP] or [SNAP+FIND], move the robot to each camera view's measurement position, and repeat the test run for each camera view again.

2 Check that the part has been found correctly, and click [Set] of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

2.3.6 Creating and Teaching a TP Program

Create a TP program for the 3D fixed frame offset system by measuring multiple points using the 3DV Sensor. Below is an example TP program and an explanation of the position registers.

Position registers

PR [1: Home]	Home position. The robot's waiting position and posture when it is not doing any work.
PR [2: Search1]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 1.
PR [3: Search2]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 2.
PR [4: Search3]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 3.
PR [5: Search4]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 4.
PR [6: Pick Approach]	The approach position when picking the part. In most cases, it is right above the part that needs to be picked up.
PR [7: Pick]	The part pick position. It is the position at which the part is actually picked up (grasped).
PR [8: Pick Retract]	The pick retraction position. A relay point when moving from the pick position to the placement position.
PR [9: Place Approach]	The placement approach position.
PR [10: Place]	The placement position.
PR [11: Place Retract]	The place retraction position. It can be the same position and posture as PR[9].

```
 1:  UFRAME_NUM=1
 2:  UTOOL_NUM=1
 3:  J PR[1:Home] 30% FINE
 4:
 5:  LBL[10]
 6:  !SEARCH 1
 7:  J PR[2:Search1] 100% FINE
 8:  WAIT    .30(sec)
 9:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[1]
10:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[1]
11:  IF R[14]<1,JMP LBL[999]
12:
13:  !SEARCH 2
14:  J PR[3:Search2] 100% FINE
15:  WAIT    .30(sec)
16:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[2]
17:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[2]
18:  IF R[14]<1,JMP LBL[999]
19:
20:  !SEARCH 3
21:  J PR[4:Search3] 100% FINE
22:  WAIT    .30(sec)
23:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[3]
24:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[3]
25:  IF R[14]<1,JMP LBL[999]
26:
27:  !SEARCH 4
28:  J PR[5:Search4] 100% FINE
29:  WAIT    .30(sec)
30:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[4]
31:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[4]
32:  IF R[14]<1,JMP LBL[999]
33:
34:  !GET OFFSET DATA
35:  VISION GET_OFFSET 'V_3DV_MULTI' VR[1] JMP LBL[999]
36:
37:  !PICK
38:  L PR[6:Pick Approach] 800mm/sec CNT100 VOFFSET,VR[1]
39:  L PR[7:Pick] 200mm/sec FINE VOFFSET,VR[1]
40:  !Insert program instraction to grasp the part
41:  CALL ...
42:  L PR[8:Pick Retract] 800mm/sec CNT100 VOFFSET,VR[1]
43:
44:  !PLACE
45:  L PR[9:Place Approach] 800mm/sec CNT100
46:  L PR[10:Place] 200mm/sec FINE
47:  !Insert program instraction to release the part
48:  CALL ...
49:  L PR[11:Place Retract] 800mm/sec CNT100
50:  JMP LBL[10]
51:
52:  !ERROR
53:  LBL[999]
```

- Line 1: Specify the user frame number set in “2.3.2 User Frame Setting”.
- Line 2: Specify the tool frame number set in “2.3.4 Tool Frame Setting”.
- Line 8: Wait for robot-vibration to reduce.
- Line 9: Execute measurement of Camera View 1.
- Line 10: Get the number of found for Camera View 1.
- Line 11: Jump to the last row when not found for Camera View 1.
- Line 35: Get the offset data in the measurement results (jump to the last row when failed to get).
- Line 39: Move to the part pick position.
- Line 46: Move to the part placement position.

✐Memo

For the CALL commands on lines 41 and 48, specify the commands to grasp and release the part, respectively.

2.3.7 Checking Robot Offset Operation

Check that a part on the table can be detected and picked up accurately.
The detection results and offset data acquisition results from the vision command can be checked on the vision runtime screen. For details about the vision runtime screen, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

> **Memo**
> Here, you need to move the part to check the operation. Move the part so that the part features taught for each camera view are within the field of view for each camera view, and then check operation.

- Place the part near the reference position, find it and check that it can be picked up accurately. If the accuracy of compensation is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation, find it and check that it can be picked up accurately.
- Rotate the part, find it and check that it can be picked up accurately. If the part near the reference position can be picked up accurately but the accuracy decreases as the part rotates, the settings of the calibration grid and of the frame used for offset may not have been performed accurately. If you set the frame with a pointer tool, check the accuracy of touch-up and retry calibrating the 3DV Sensor.
- Change the part's height, find it and check that it can be picked up accurately.
- Tilt the part, find it and check that it can be picked up accurately.

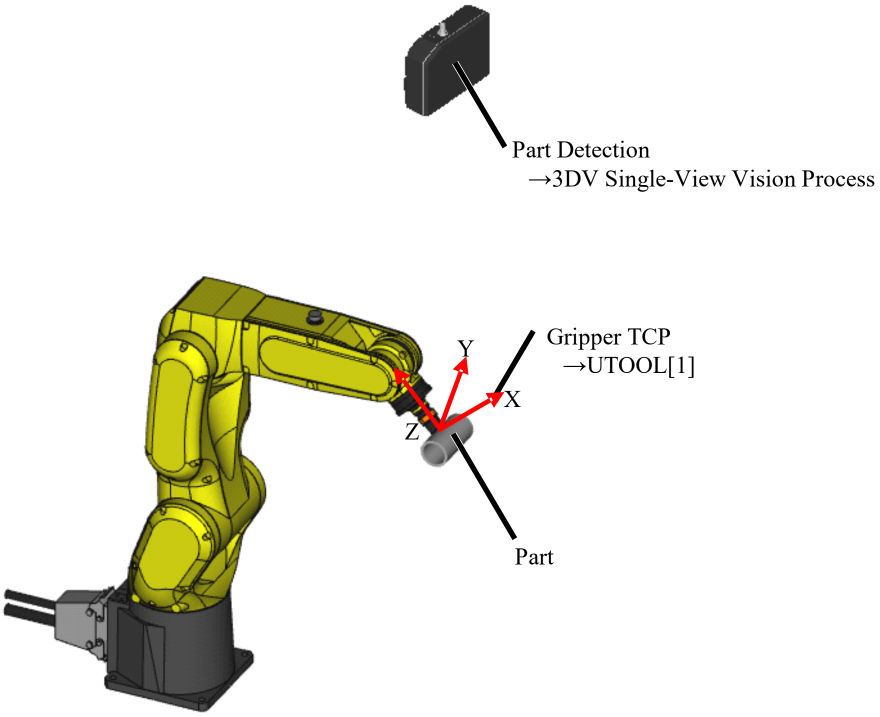
3 3D TOOL OFFSET SYSTEM

This chapter explains the setup procedures of the 3D tool offset system using a fixed camera.

> ✐**Memo**
> This chapter describes the screens and operations in the simple mode unless otherwise noted. For details on the Simple Mode and Advanced Mode, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3.1 3D SINGLE-VIEW TOOL OFFSET SYSTEM USING A FIXED CAMERA

This section explains the setup procedure of the 3D tool offset system using a fixed camera to measure one location with the setup in the following figure.



Example of a 3D single-view tool offset system configuration

3.1.1 Installation and Connection of 3DV Sensor

Installation of the 3DV Sensor

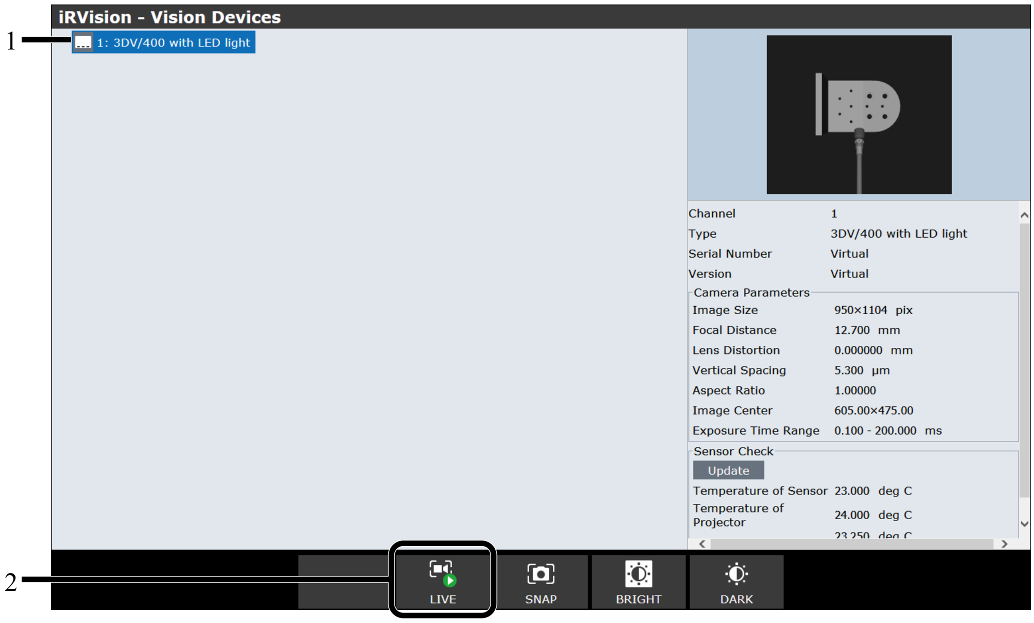
Install the 3DV Sensor on the camera mount.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.



1 On the ROBOT Homepage, select [*i*RVision] →[Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.

2 Click [LIVE] and check that continuously snapped images are displayed.

3.1.2 Creating and Setting up 3DV Sensor Data

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the fixed camera according to the procedures described in “Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA.”
This system has pre-installed sample 3DV Sensor Data. It is convenient to change the settings as necessary based on the sample. This chapter explains the operations assuming that the sample 3DV Sensor Data will be used.

3.1.3 Tool Frame Setting

Set a tool frame in the center of the end of the gripper claw or the pad to grasp a part. This frame is useful for correcting the motion of the robot to accurately place a grasped part at the fixed position.
The Z-axis of this frame should be set along the direction of the gripper holding the part. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure ‘Example of a 3D single-view tool offset system configuration’ at the beginning of this section. For how to set up the tool frame, refer to “Know-How: 1 FRAME SETTING.”

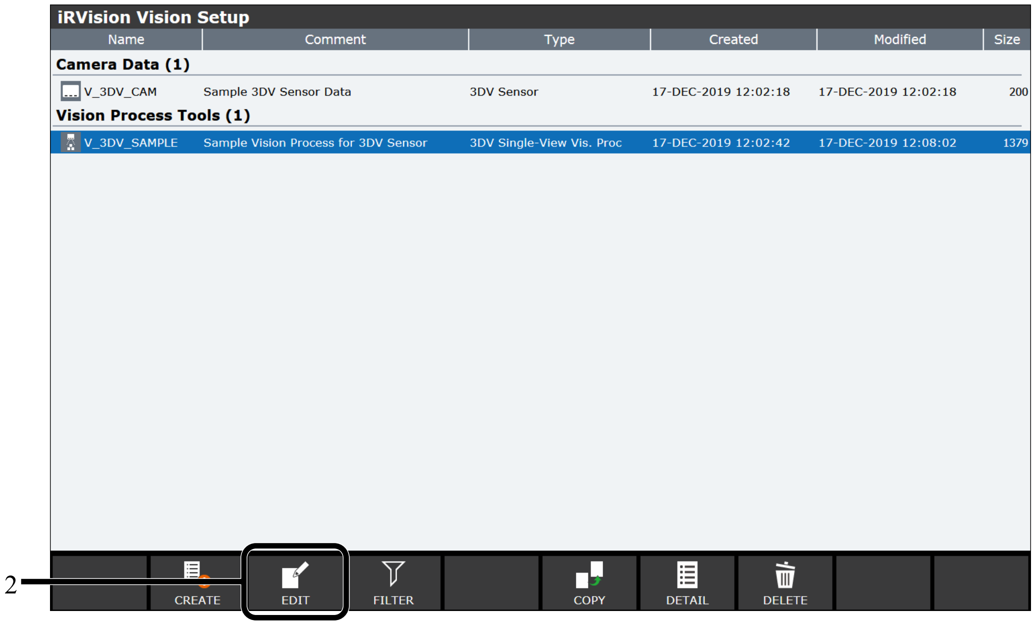
3.1.4 Setting up Vision Process

Set up a "3DV Single-View Vision Process."
This system has a pre-installed sample vision process. The following explains the procedure for editing the settings based on that sample.

3.1.4.1 Editing vision process

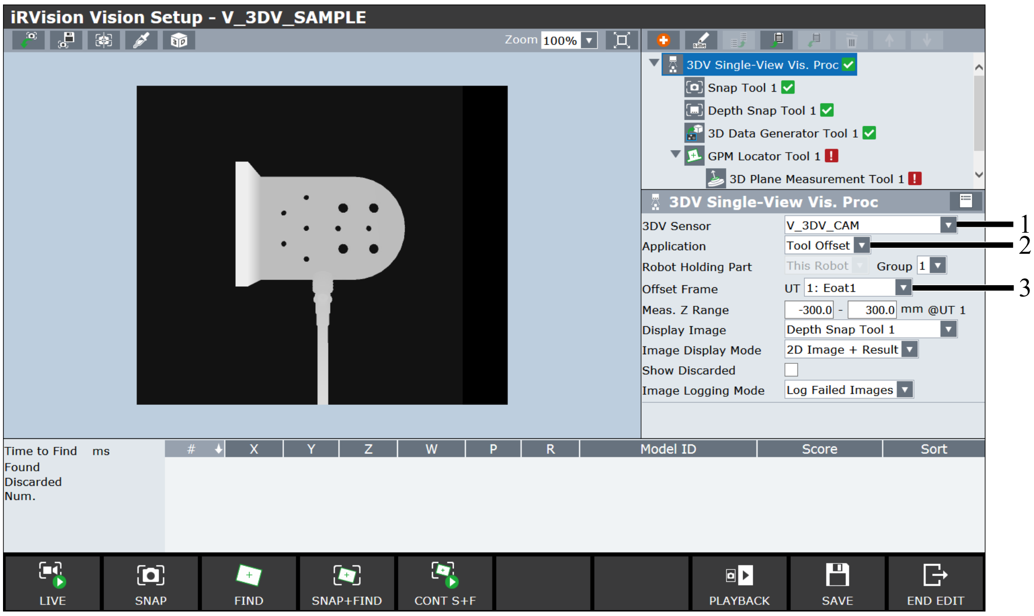
Select the sample vision process and open the edit screen.

1 Click [V_3DV_SAMPLE] in the [Vision Process Tools] category on the vision data list screen.



2 Click [EDIT].
The vision process setup screen appears.

3.1.4.2 Setting parameters of vision process



1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 Select [Tool Offset] from the [Application] drop-down box.
3 Select [1] from the [Offset Frame] drop-down box.
Offset frame is the tool frame used for calculation of offset.
Select the tool frame number set in “Setup: 3.1.3 Tool Frame Setting.”
4 Hold the part with the gripper and jog the robot so that the part will come into the 3DV Sensor’s field of view.
5 Teach the robot position in the robot program.
Teach the current position as the part detection position in the robot program.
This system comes with the sample TP program for tool offset installed. The details are described in “Setup: 3.1.5 Editing TP Program.” The part measurement position is P[2] on the twelfth row in the sample TP program.

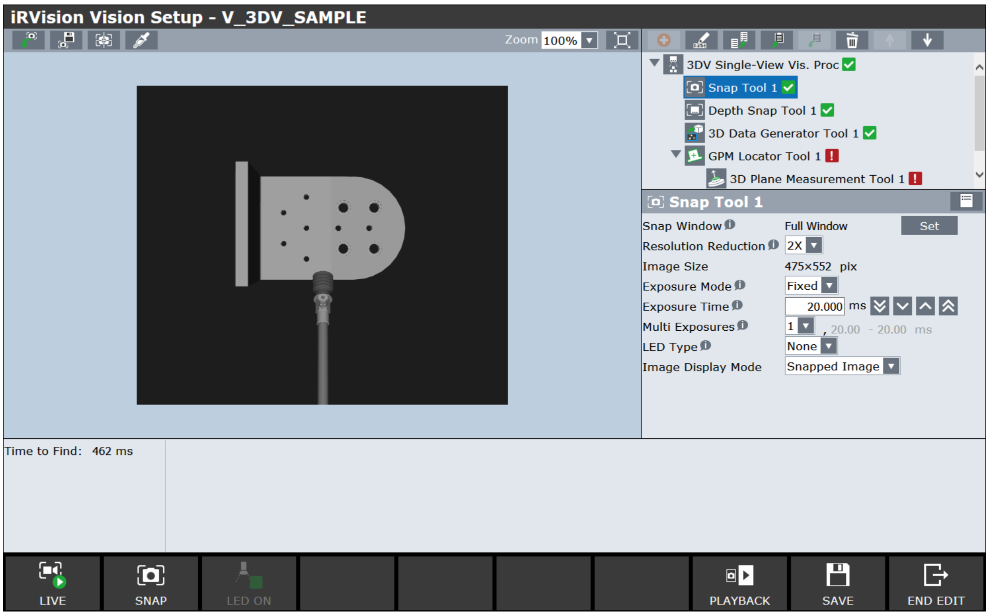
NOTE

When working on step 4, make sure that the part will not be hidden behind the robot or the gripper. From this point forward, do not move the part and robot until teaching of the robot motion when the part is placed at the reference position is finished in the TP program for tool offset.

3.1.4.3 Teaching Snap Tool

Set parameters for snapping 2D images.

Select [Snap Tool 1] in the tree view to open the snap tool teaching screen. In most cases, you can use the initial settings for the sample as they are. However, if the image is too dark or bright, adjust [Exposure Time] or select [HDR] in [Exposure Mode].
For details on the snap tool, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."



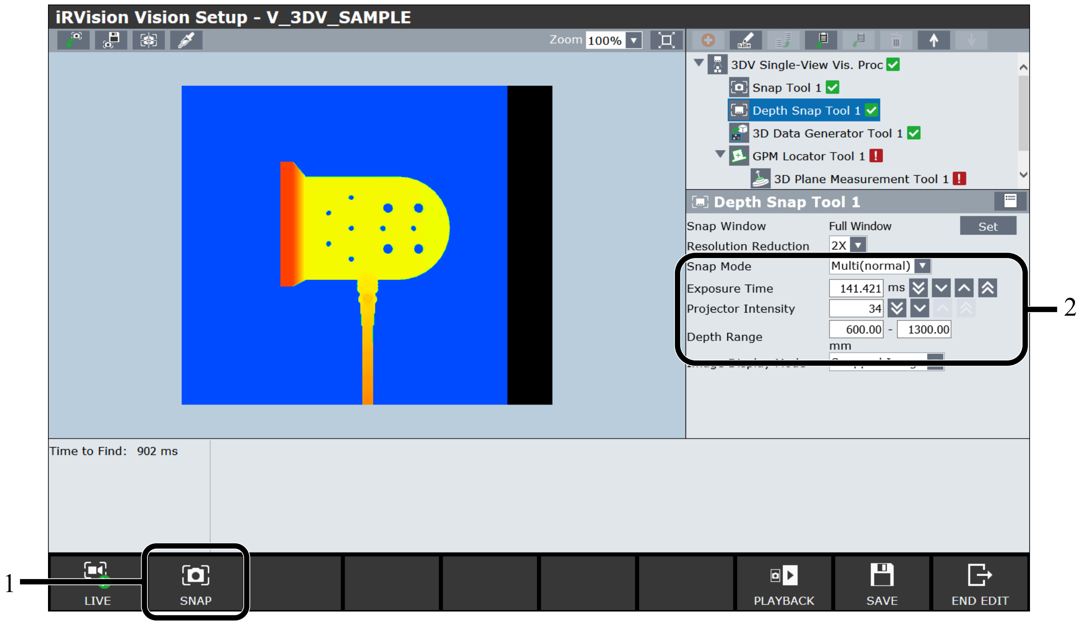
Memo

1. If the image is still too dark even when the exposure time is set to the maximum (200 ms), change [LED Type] to [3DV Sensor] and then adjust the "Exposure Time."
2. The [HDR] option of [Exposure Mode] combines images snapped at multiple exposure times, automatically selected according to the surrounding brightness, into a single image with a wide dynamic range.

3.1.4.4 Teaching Depth Snap Tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



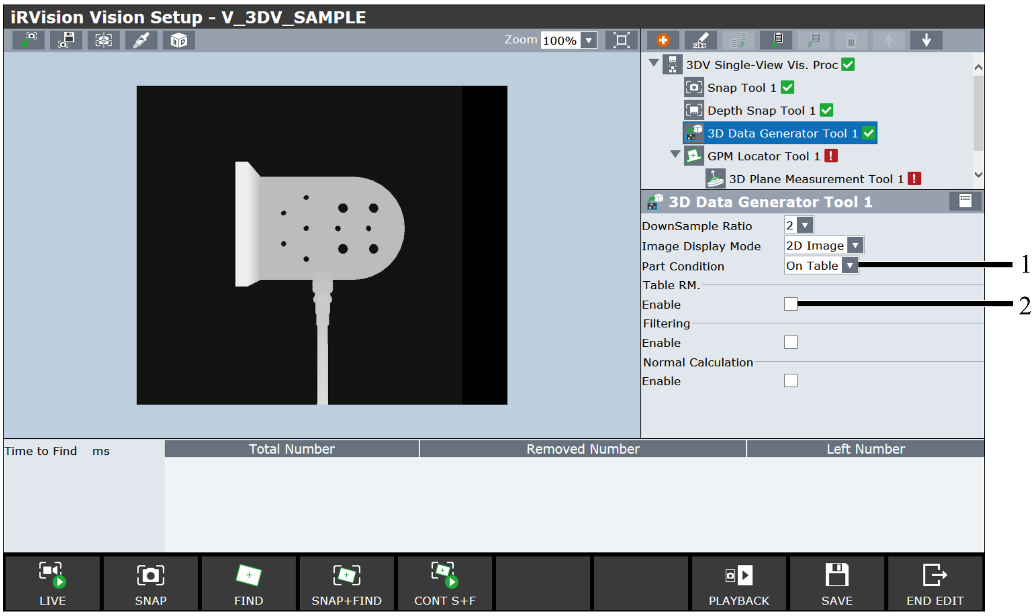
1 Click [SNAP].
2 Adjust each parameter so that measurement omission (black area) is removed from the part to be measured. For details on each parameter, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN". Repeat the procedure starting from step 1 until the parameters are adjusted appropriately.

> ✎**Memo**
> Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to "Setup: 2.4 3D VISION SENSOR" in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3.1.4.5 Setting parameters of 3D Data Generator Tool

Select [3D Data Generator Tool] in the tree view, and then set each item.

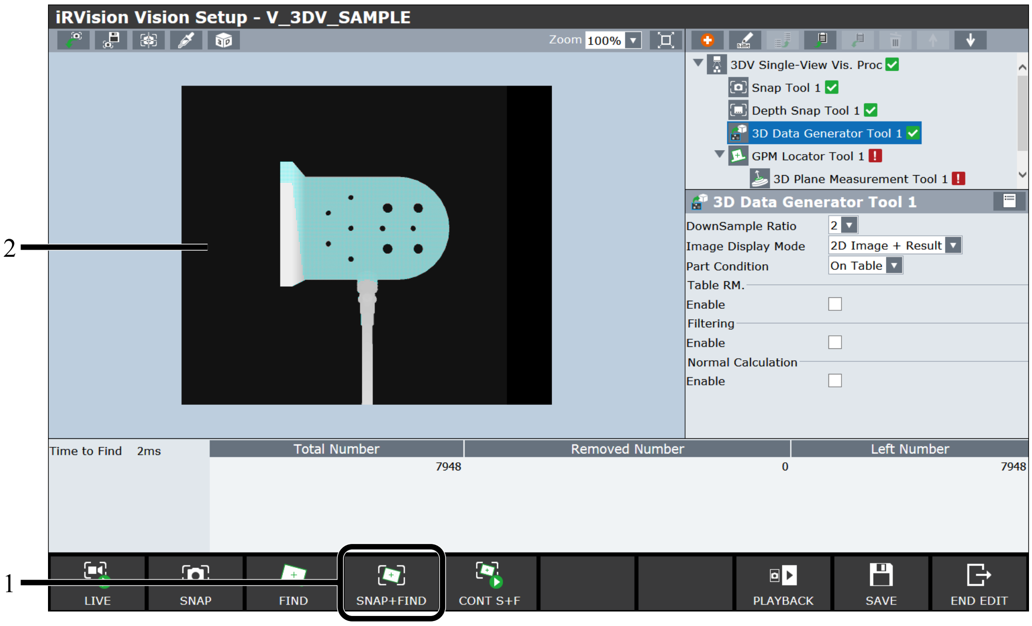
Setting parameters



1 Select [On Table] from the [Part Condition] drop-down box.
2 Uncheck the checkbox of [Enable] in [Table RM.].

Running a test

Check that 3D points necessary for the part detection have been detected correctly.



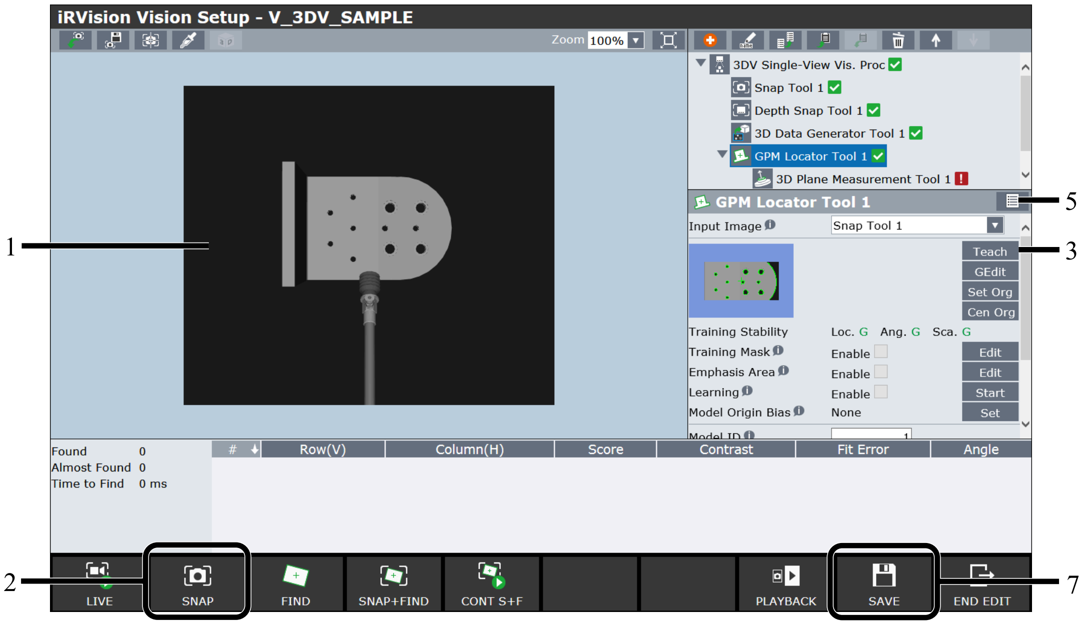
1 Click [SNAP+FIND]. An image is snapped and detection is performed.
2 Check that only necessary 3D points have been found and are shown in light blue.

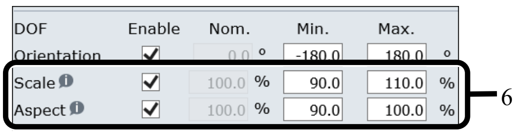
> **Memo**
> If many 3D points other than the part are found, it may be improved by checking the [Enable] checkbox in [Table RM.] and adjusting the table height.
> If [Table RM.] is enabled, the removed 3D point cloud will be displayed in red. Check that the areas other than the part are displayed in red.

3.1.4.6 Teaching GPM Locator Tool

Set parameters for 2D measurement (detection of 2D features).
Select [GPM Locator Tool 1] in the tree view, and then set each item.

Setting parameters





1 Place the part so that it is within the camera view.
2 Click [SNAP] to snap an image.
3 Click the [Teach] button to teach the model.
The GPM Locator Tool model setup screen appears. Teach 2D features used for position detection. Select features of the model on the same plane to reduce the effects of changes in shape due to parallax. For features that do not need to be included in the model, [Training Mask] can be set to exclude them from the teach model. For details on teaching 2D features, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
4 Check that the pattern that you want to use as the model has been plotted with a green line and that the model origin (green cross) is on the plane of the pattern.

> **Memo**
> If the model origin is not on the same plane as the pattern, click the [Set Org.] button and move the model origin onto the same plane as the pattern.

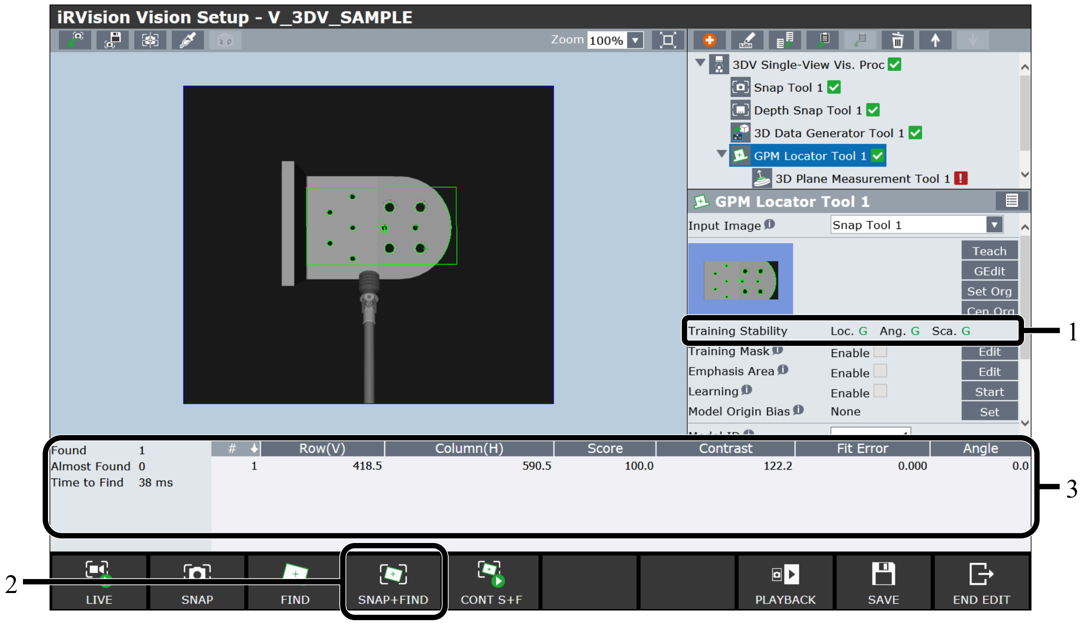
5 Click ▤ to switch to advanced mode.
6 Check the checkboxes of [Scale] and [Aspect] in [DOF].

Memo

Change the [Min.] and [Max.] settings for [Orientation], [Scale], and [Aspect] in [DOF] as necessary. If the distance between the camera and the part varies widely, consider expanding the [Scale] search range setting. If the tilt between the camera and the part varies widely, consider expanding the [Aspect] search range setting. Also, if misdetection of the part seems to increase, consider decreasing the search range parameters. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

7 Click [SAVE].

Running a test



1 Check [Training Stability]
This item provides a guideline indicating whether the position, angle and size are detected correctly in the taught model. Evaluations are indicated with [G] (good), [P] (poor) and [N] (none). [N] indicates that stable detection of the model may be impossible.
In such a case, change the model, or uncheck [Enable] for the parameter in question in [DOF].

2 Click [SNAP+FIND].
An image is snapped and detection is performed.

3 Check that the same pattern as the model has been plotted with a green line. Then, check the score, contrast, and other results of the detected model on the test result display area. If the score and contrast values are higher than the set thresholds by at least 10 points, there is no problem.

Memo

Adjust parameters of the GPM Locator Tool if there is a problem. Some parameters are displayed only in the advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

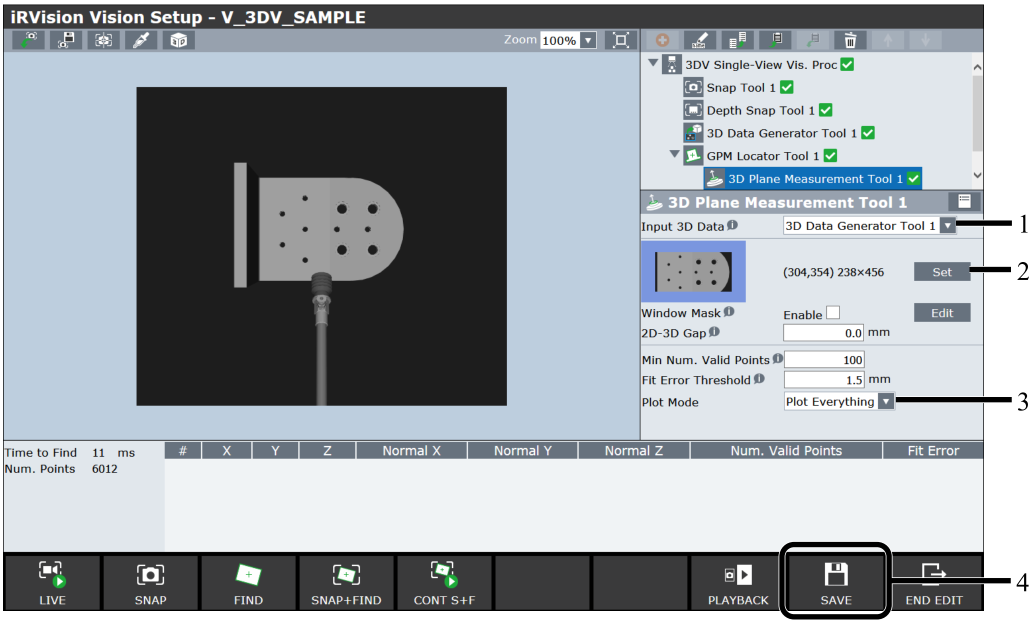
4 Change the part position and repeat the same check several times.

3.1.4.7 Setting up 3D Plane Measurement Tool

Set parameters for detecting the plane near the 2D feature position detected with the GPM Locator Tool from 3D points.
Select [3D Plane Measurement Tool] in the tree view, and then set each item.

3

Setting parameters



1 Select [3D Data Generator Tool 1] for [Input 3D data].
2 Click the [Set] button.
The green lines shown in the image are the model and the area taught with pattern matching, and the area inside the red frame is the plane measurement area. When the measurement area is first taught, the red frame will be shown overlapping the green frame, but this can be changed. For details on the measurement area teaching screen for plane measurement, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Once the measurement area has been taught, a thumbnail of the image used for teaching appears, and the position and size of the area appear.

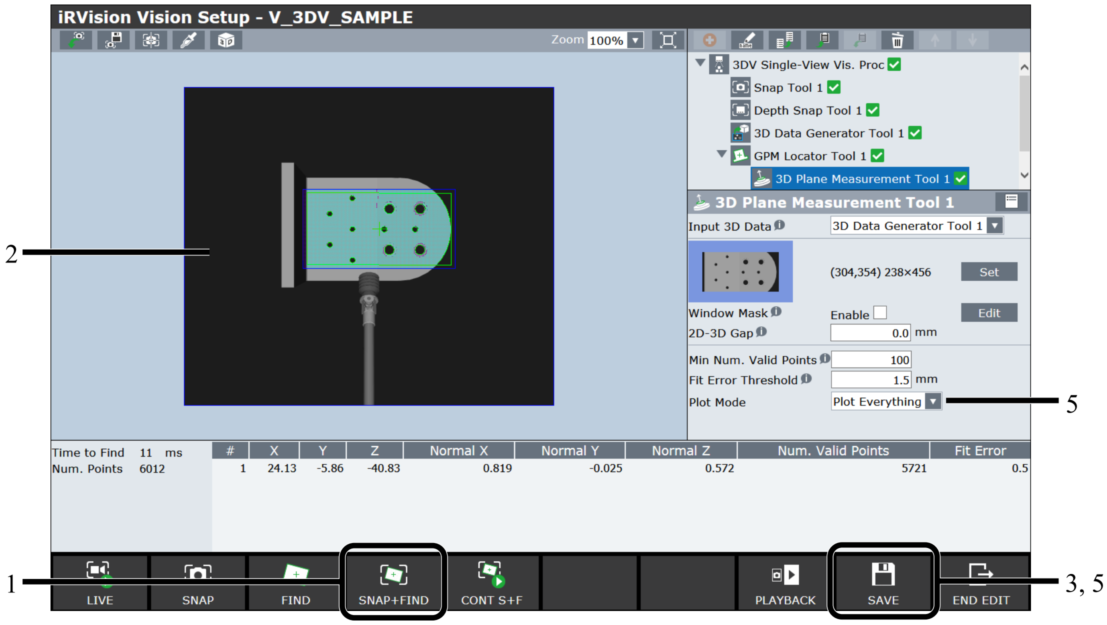
> **Memo**
> If the model origin for the GPM Locator Tool is not in the plane you want to measure, change [2D-3D Gap]. If the model origin is above the Z direction as seen from the plane you want to measure, specify a positive value for this setting. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3 Change [Plot Mode] to [Plot Everything].
4 Click [SAVE].

> ⚠ **CAUTION**
> Before setting the 3D Plane Measurement Tool, complete the setting of the GPM Locator Tool. Also, the measurement area must be taught again if the model of the GPM Locator Tool is changed.

Running a test

Check whether the taught area is appropriate. If necessary, adjust parameters to enable stable detection.



1 Click [SNAP+FIND].
An image is snapped and detection is performed.

2 Check that a light blue plot is displayed on the surface of the part that you want to measure.

Memo

1 Adjust parameters of the 3D Plane Measurement Tool if there is a problem. For example, if a light blue plot is displayed on a surface other than the one that you want to measure, teach [Window Mask]. Also, some parameters are displayed only in advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2 Change the measurement area according to the shape of the part.

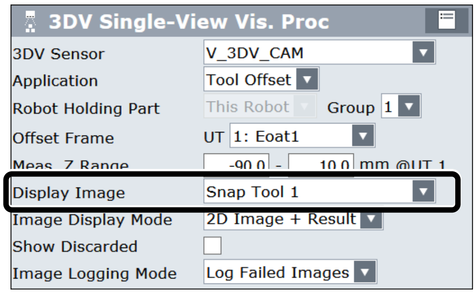
3 Click [SAVE].

4 Repeat steps 1 to 3 by changing the tilt of the plane.

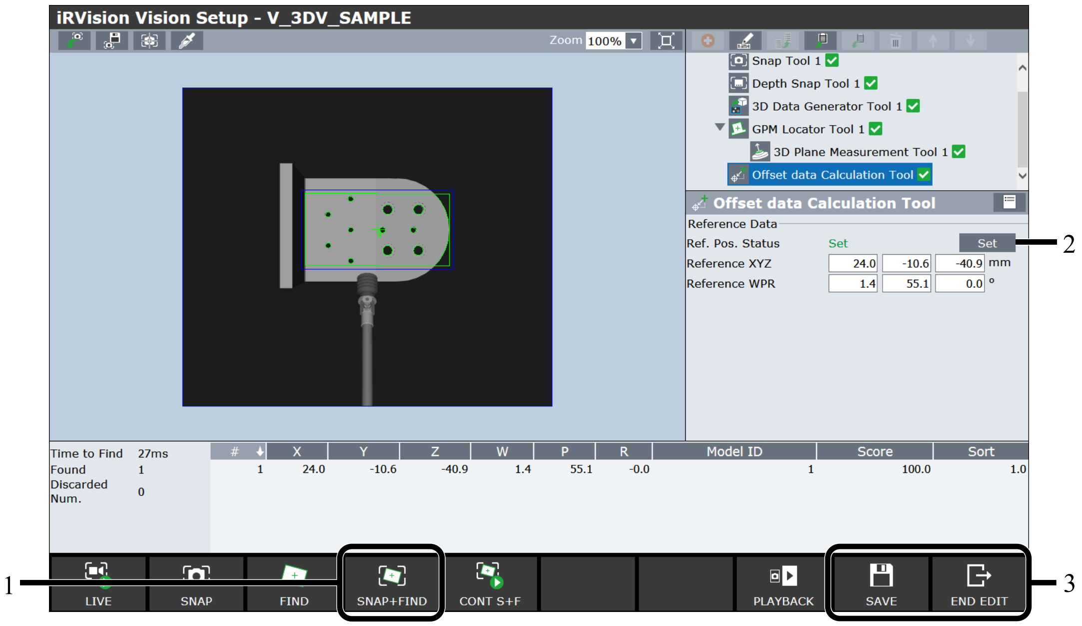
5 If there is no problem with the test run, change the option for [Plot Mode] to [Plot Measurement Area] and click [SAVE] again.

3.1.4.8 Setting reference position

Here, hold a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.
In preparation, select [3DV Single-View Vis. Proc] in the tree view, and select [Snap Tool 1] for [Display Image].



Then, select [Offset data Calculation Tool] in the tree view, and then set each item.



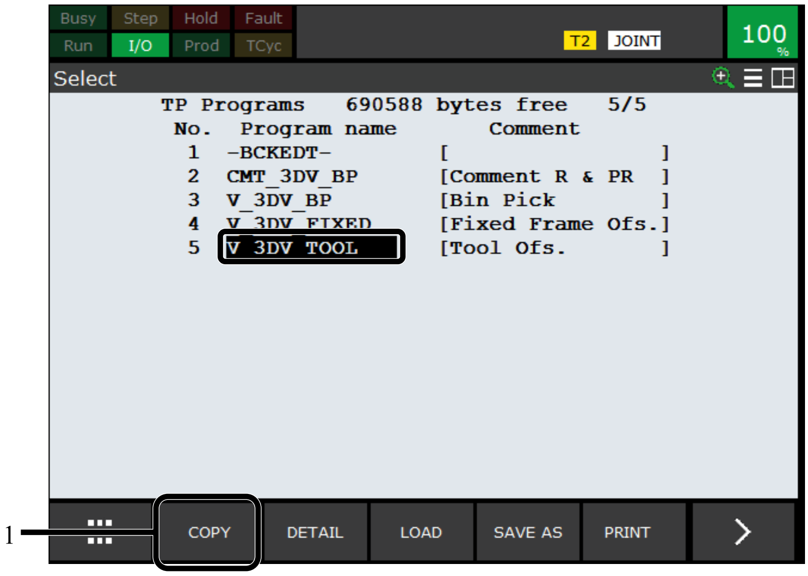
1 Click [SNAP+FIND] to find the part.
2 Check that the part has been found correctly, and click the [Set] button of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

3.1.5 Editing TP Program

Edit the TP program for 3D tool offset system with a 3DV Sensor.
This system has a pre-installed sample program. This section explains how to create a program for transporting a part while actually performing 3D tool offset based on this sample program.

Copying the sample program

1 Select [V_3DV_TOOL] and click [COPY] on the program list screen.



2 Edit the program name and click [OK].

Editing the program

1 Open the copied program and teach the following positions.

Positions

P[1: Home]	Home position. The robot's waiting position and posture when it is not doing anything.
P[2: Search]	The detection position. The robot's position and posture when the sensor has found the part.
P[3: Place Approach]	The approach position when placing the part.
P[4: Place]	The part placement position. It is the position at which the part is actually placed (released).
P[5: Place Retract]	The place retraction position. It is a relay point when moving from the placement position to the home position.

```
!The register number and
!position register number below
!should be changed and commented
!as necessary.

UFRAME_NUM=1
UTOOL_NUM=1
J P[1:Home] 100% FINE
R[1]=0

!SEARCH
J P[2:Search] 50% FINE
WAIT (R[1])
VISION RUN_FIND 'V_3DV_SAMPLE'
VISION GET_OFFSET 'V_3DV_SAMPLE'
VR[1] JMP LBL[100]

!PLACE
L P[3:Place Approach] 2000mm/sec CNT100
VOFFSET,VR[1] Offset,PR[1]
L P[4:Place] 500mm/sec FINE VOFFSET,VR[1]
!Insert program instruction
!to release the part
CALL ...
L P[5:Place Retract] 2000mm/sec CNT100
VOFFSET,VR[1] Offset,PR[1]
JMP LBL[999]

!ERROR
LBL[100]
R[1]=1

LBL[999]
```

Specify the tool frame number set in "3.1.3 Tool Frame Setting."

Execute measurement.

Get offset data of the measurement result.

Execute tool offset and the process to place the part.

2 Specify the instruction to release the part after the P[4] motion instruction using the CALL instruction.

3.1.6 Checking Robot Offset Operation

Check that a part gripped by the robot can be detected and placed precisely.
Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

- Grasp the part on the reference position, find it and check the handling accuracy. If the handling accuracy is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation and find it while gripping it to check the handling accuracy.
- Rotate the part and find it while gripping it to check the handling accuracy. If the part near the reference position can be handled accurately but the accuracy decreases as the part rotates and is grasped, the settings of the calibration grid and of the frame used for offset may not have been performed accurately. If you set the frame with a pointer tool, check the accuracy of touch-up and retry calibrating the 3DV Sensor.
- Change the distance from the camera to the part and find it while gripping it to check the handling accuracy.
- Tilt the part and find it while gripping it to check the handling accuracy.

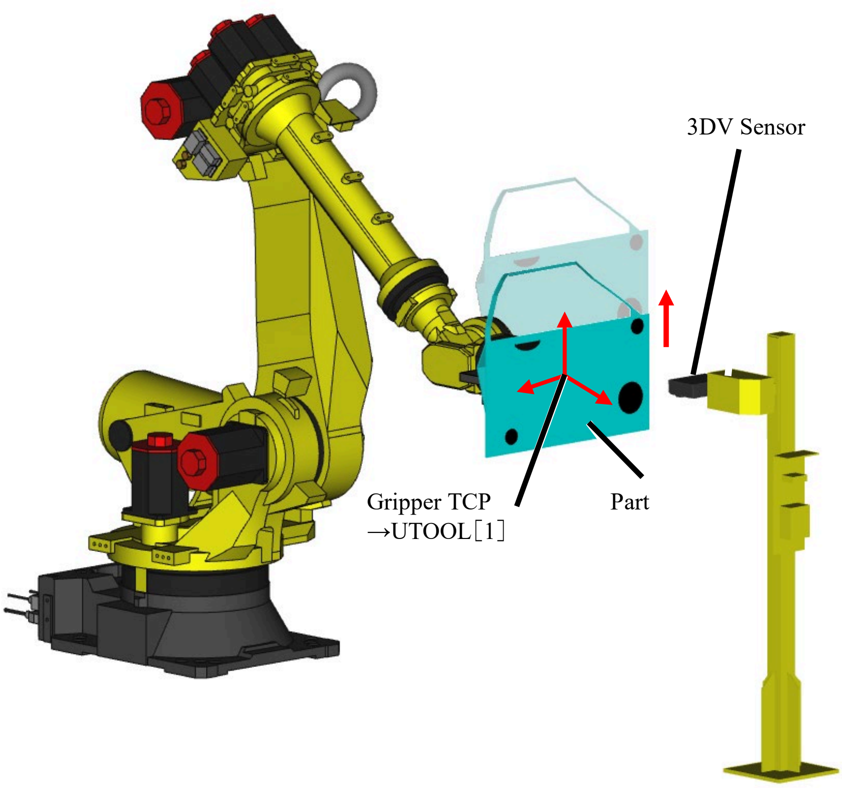
Memo

Depending on the shape of the part and the gripper, it may not be possible to grip the part in the states described above. If this is the case, the check is not required.

3.2 3D MULTI-VIEW TOOL OFFSET SYSTEM USING A FIXED CAMERA

When 3D tool offset is used with a large part that does not fit within the 3DV Sensor's field of view, this function can be used to perform fixed frame offset with a greater accuracy than measuring one location. This section explains the setup procedures of the 3D tool offset system using one fixed camera to measure multiple locations.

> **Memo**
> With this system, measurement is performed at multiple measurement points. The offset precision is improved by selecting measurement points that are as far apart as possible. If possible, measuring with multiple cameras is preferable.



Example of a 3D multi-view tool offset system configuration

3.2.1 Installation and Connection of 3DV Sensor

Installation of the 3DV Sensor

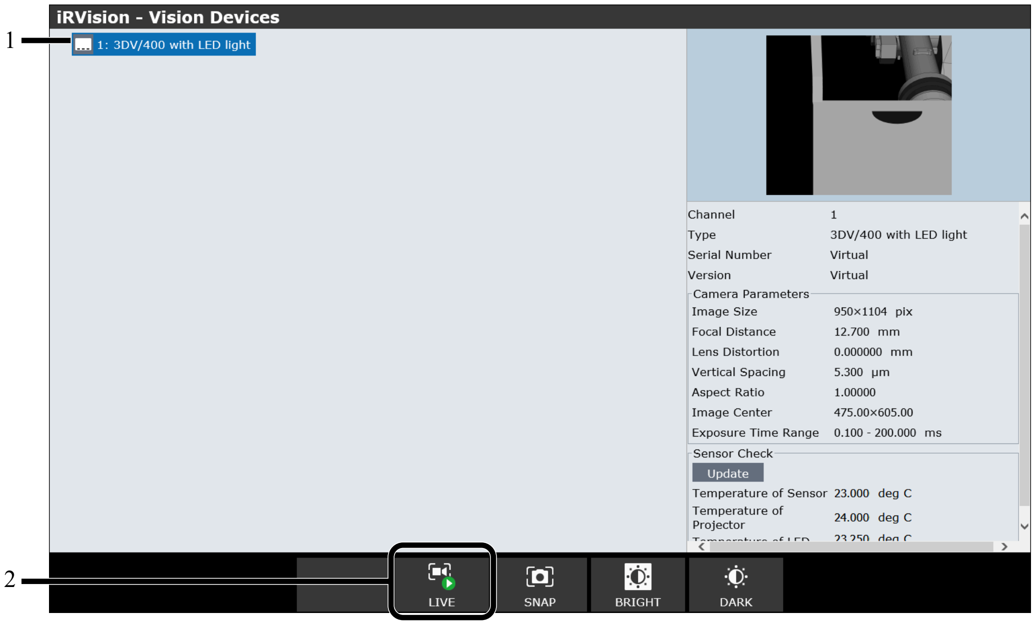
Install the 3DV Sensor on the camera mount.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.



1 On the ROBOT Homepage, select [*i*RVision] → [Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.

2 Click [LIVE] and check that continuously snapped images are displayed.

3.2.2 Creating and Setting up 3DV Sensor Data

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the fixed camera according to the procedures described in “Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA.”
This system has pre-installed sample 3DV Sensor Data. It is convenient to change the settings as necessary based on the sample. This chapter explains the operations assuming that the sample 3DV Sensor Data will be used.

3.2.3 Tool Frame Setting

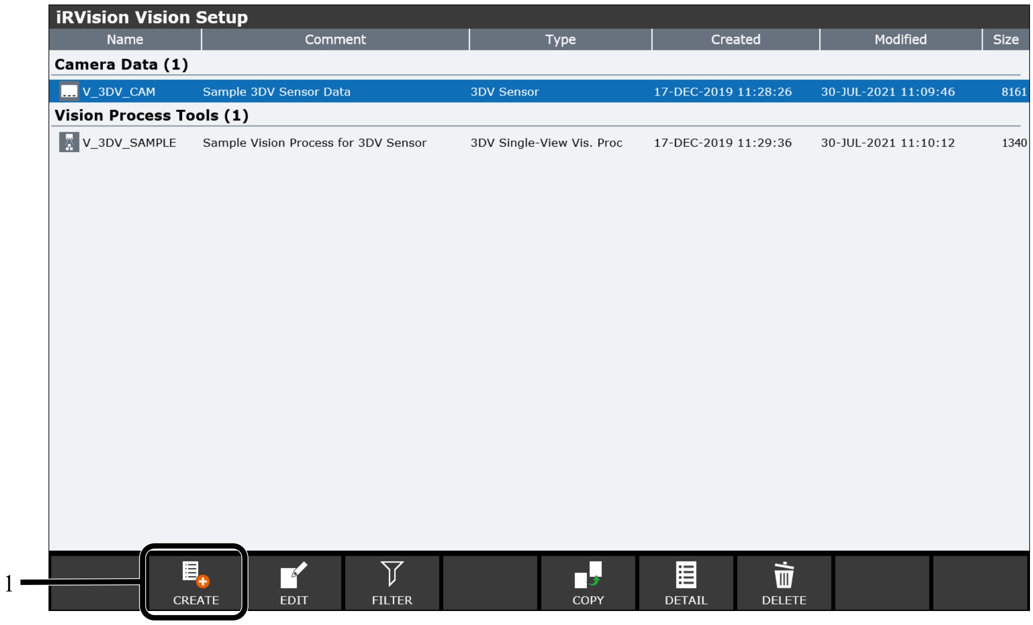
Set a tool frame in the center of the end of the gripper claw or the pad to grasp a part. This frame is useful for correcting the motion of the robot to accurately place a grasped part at the fixed position.
The Z-axis of this frame should be set along the direction of the gripper holding the part. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure ‘Example of a 3D multi-view tool offset system configuration’ at the beginning of this section. For how to set up the tool frame, refer to “Know-How: 1 FRAME SETTING.”

3.2.4 Creating and Setting up Vision Process

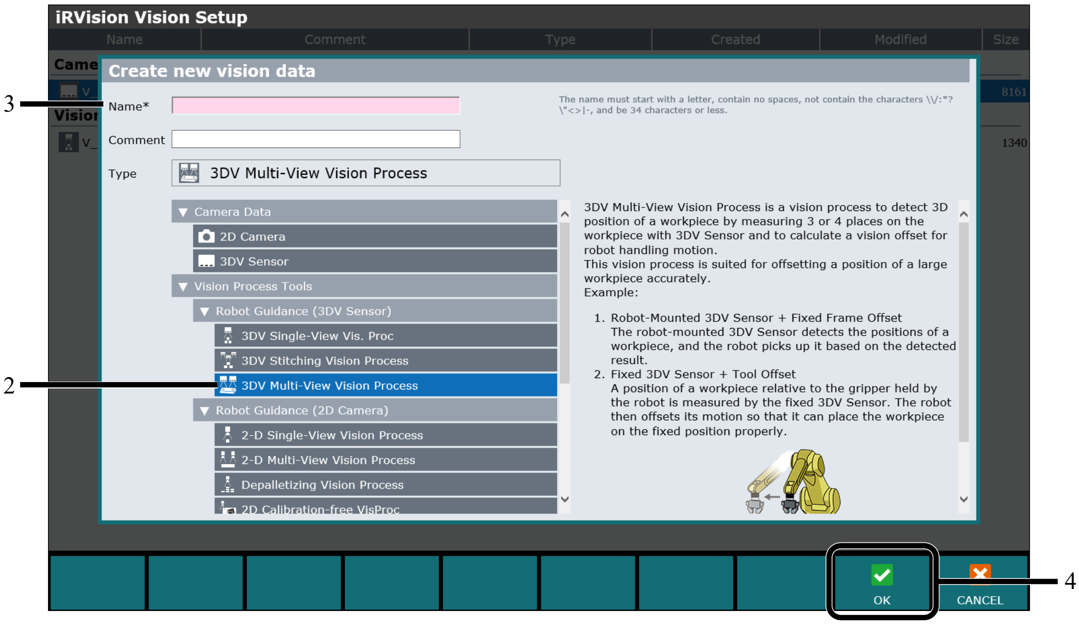
Create and set up a new “3DV Multi-View Vision Process” program.

3.2.4.1 Creating a new vision process

Create a vision process with the following procedure.

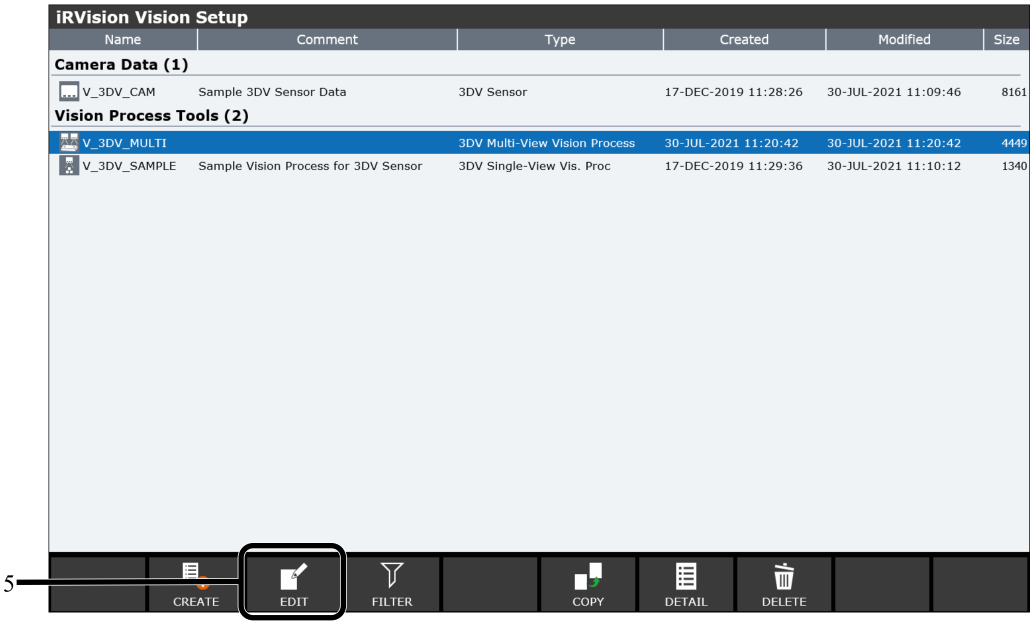


1 Click [CREATE].
A pop-up is displayed for creating new vision data.



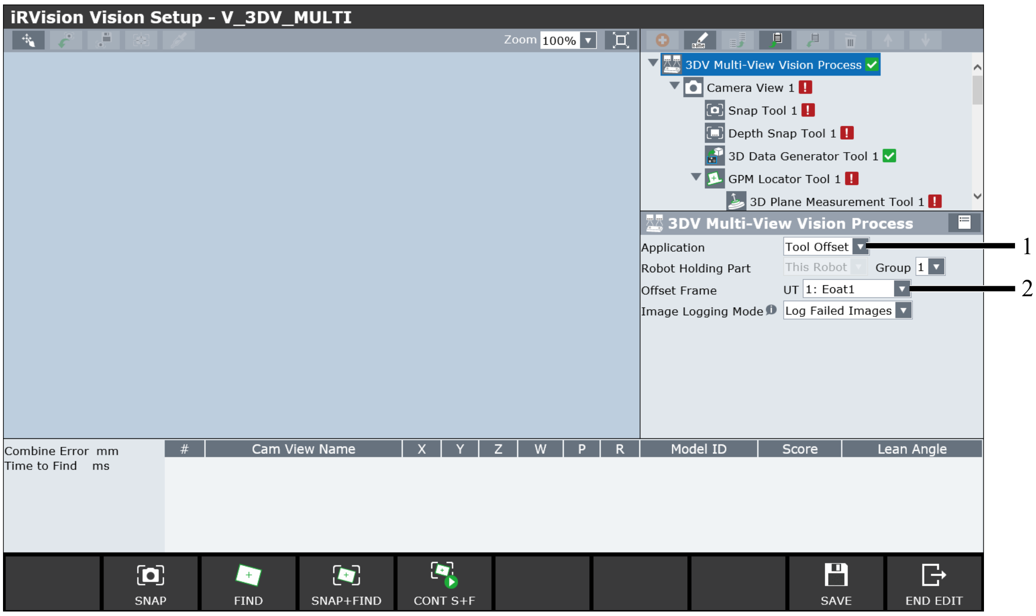
2 Select [3DV Multi-View Vision Process].
3 Enter a program name in [Name].
Give the program a unique name.

4 Click [OK].
A new program is created.



5 Click [EDIT].
The vision process setup screen appears.

3.2.4.2 Setting parameters of vision process



1 Select [Tool Offset] from the [Application] drop-down box.
2 Select [1] from the [Offset Frame] drop-down box.
Offset frame is the tool frame used for calculation of offset.
Select the tool frame number set in “Setup: 3.2.3 Tool Frame Setting.”

Memo

If you click [icon] to switch to advanced mode, you can enable/disable [Camera Base Find]. If you select the [Camera Base Find] check box, the part is detected based on the 3DV Sensor's frame.
Also, with "3DV Multi-View Vision Process", multiple camera views must be set up. If [Camera Base Find] is enabled, the detection position of all camera views is the position based on the 3DV Sensor's frame.

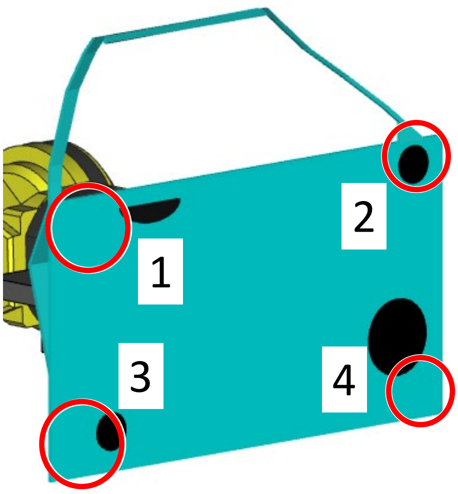
3.2.4.3 Determining the measurement point for each camera view

In the following procedures, the measurement points for the camera views will be set up. Before the setup, you must first roughly determine which parts of the work to measure.

Determine the measurement points with the camera views arranged as follows.

- The camera views are separated as much as possible.
- The camera views are not all arranged in a straight line.
- Each camera view can measure a different measurement surface to the extent possible.
  Measurement surfaces are set in "Setup: 3.2.4.9 Setting up 3D Plane Measurement Tool", but setting different planes for each camera view is preferable.
- Each camera view includes model features and a wide plane.
  Model features are taught in "Setup: 3.2.4.8 Teaching GPM Locator Tool", and wide planes are set as measurement surfaces in "Setup: 3.2.4.9 Setting up 3D Plane Measurement Tool." Accuracy is improved by setting measurement points in a way that both of these fit in the camera view.

In this section, the camera views are set up with the measurement points near the red circles in the figure below. The numbers indicate the camera view numbers.

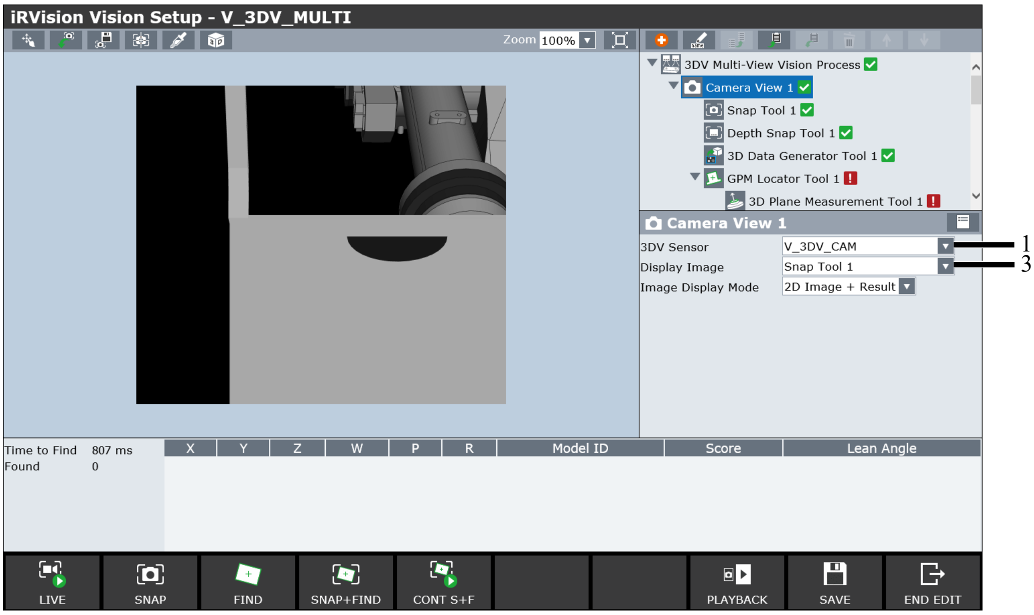


Determining the measurement points

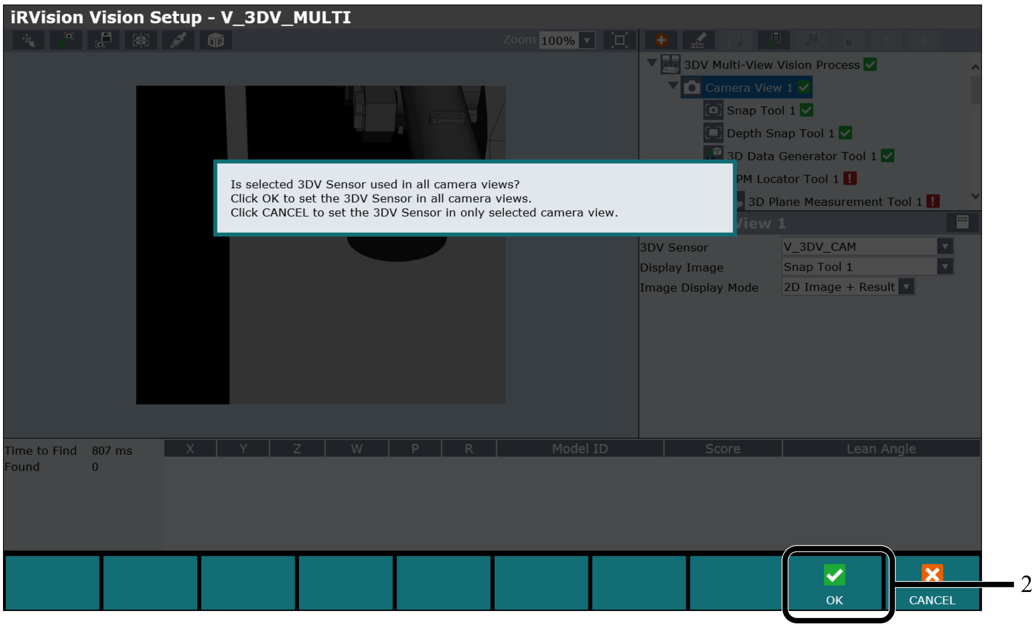
3.2.4.4 Setting up Camera View 1

Set up the 3DV Sensor to use for Camera View 1.

Setting parameters



1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 When you select [3DV Sensor], the following message appears. Here, click [OK] to use the same camera data in other camera views.



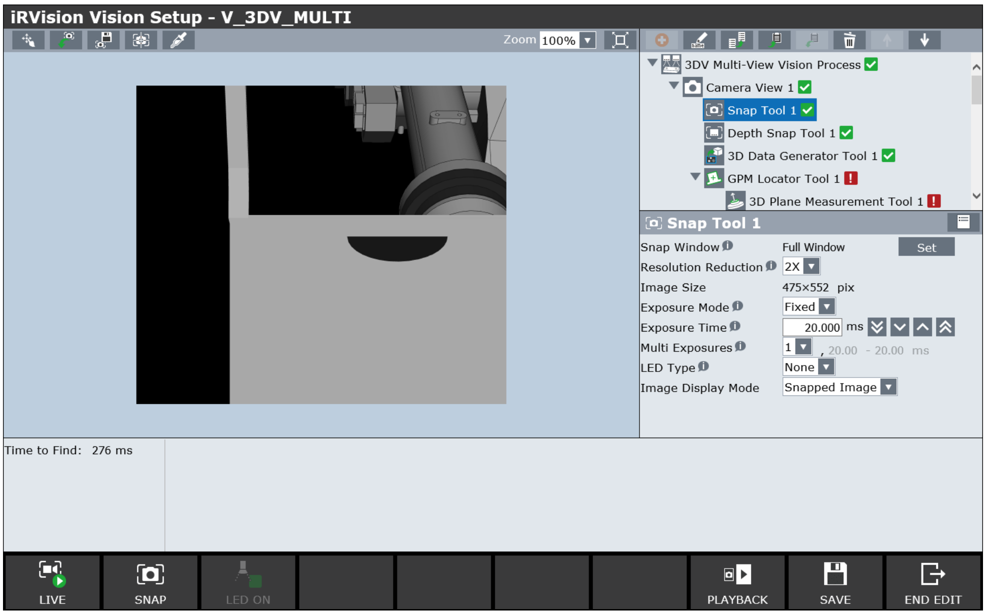
3 Select [Snap Tool 1] from the [Display Image] drop-down box.
4 Jog the robot so that the feature on the part that you want to measure with Camera View 1 is near the center of the 3DV Sensor's field of view to determine the detection position.

> **Memo**
> Once the detection position is determined, it is convenient to store the position in a position register.
> For details about setting up the position registers and an example TP program, refer to “Setup: 3.2.5 Creating and Teaching a TP Program.”

3.2.4.5 Teaching Snap Tool

Set parameters for snapping 2D images.

Select [Snap Tool 1] in the tree view to open the Snap Tool teaching screen. In most cases, you can use the initial settings for the sample as they are. However, if the image is too dark or bright, adjust [Exposure Time] or select [HDR] in [Exposure Mode].
For details on the snap tool, refer to “iRVision OPERATOR’S MANUAL (Reference) B-83914EN.”

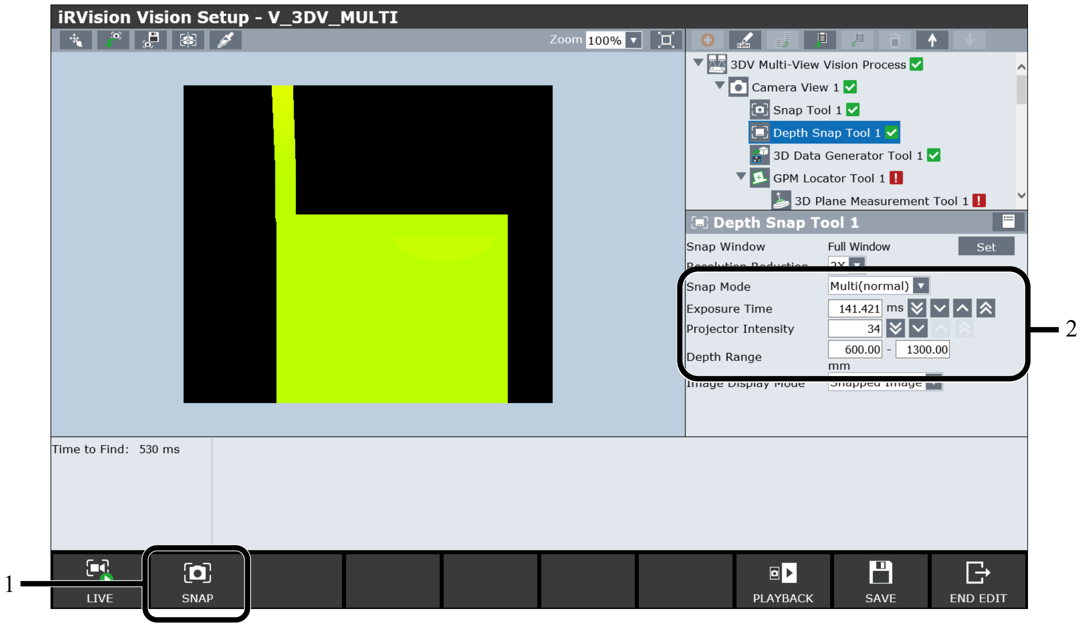


> **Memo**
> 1 If the image is still too dark even when the exposure time is set to the maximum (200 ms), change [LED Type] to [3DV Sensor] and then adjust the “Exposure Time.”
> 2 The [HDR] option of [Exposure Mode] combines images snapped at multiple exposure times, automatically selected according to the surrounding brightness, into a single image with a wide dynamic range.

3.2.4.6 Teaching Depth Snap Tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



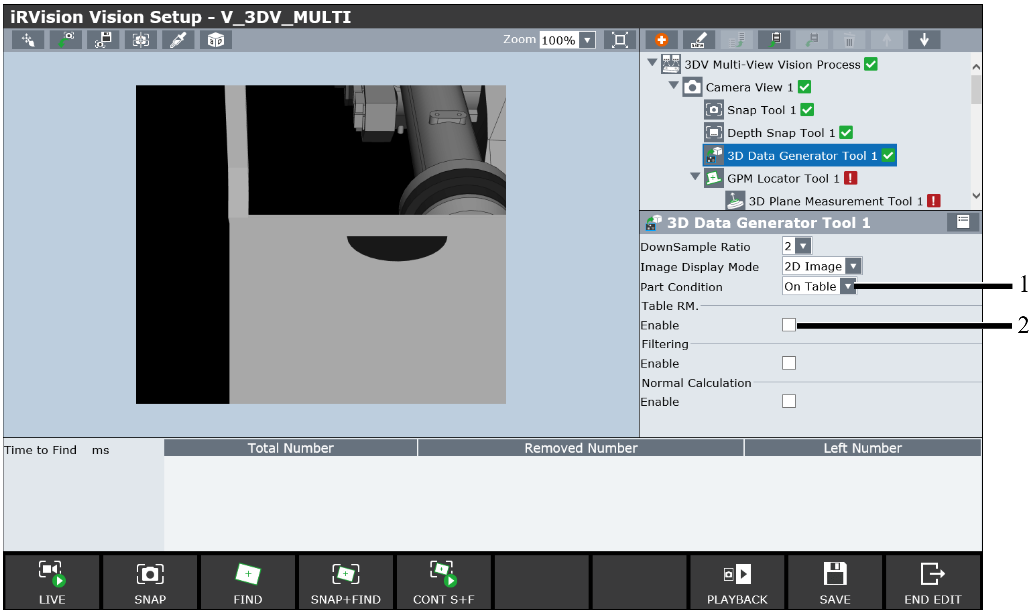
1 Click [SNAP].
2 Adjust the parameters so that measurement omission (black area) is removed from the part to be measured.
For details on each parameter, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Memo
Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to "Setup: 2.4 3DV Sensor" in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3.2.4.7 Setting parameters of 3D Data Generator Tool

Select [3D Data Generator Tool 1] in the tree view, and then set each item.

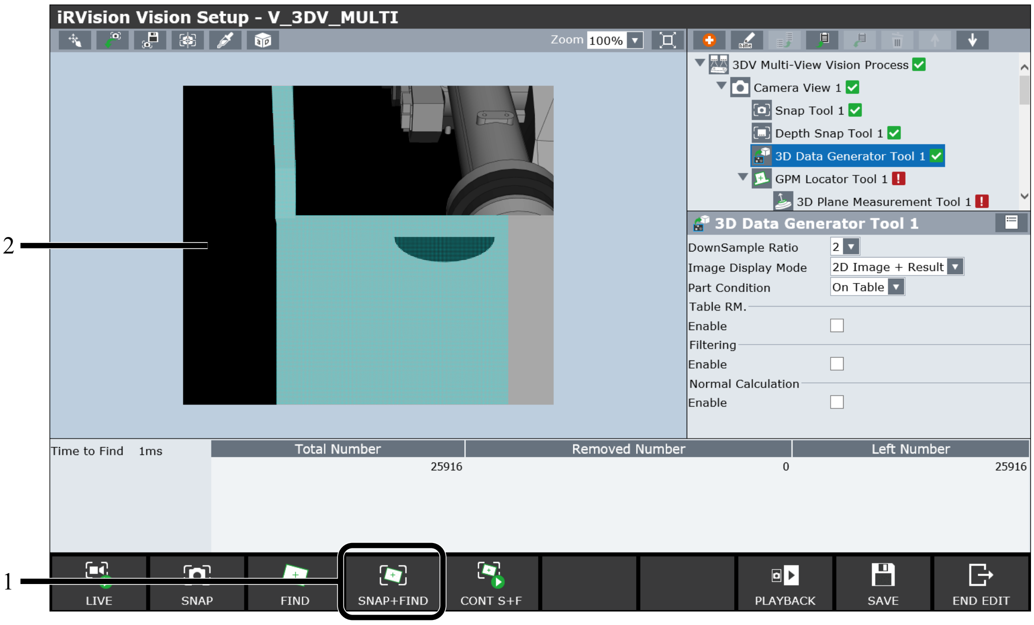
Setting parameters



1 Select [On Table] from the [Part Condition] drop-down box.
2 Uncheck the checkbox of [Enable] in [Table RM.].

Running a test

Check that the 3D points required for part detection have been detected correctly.



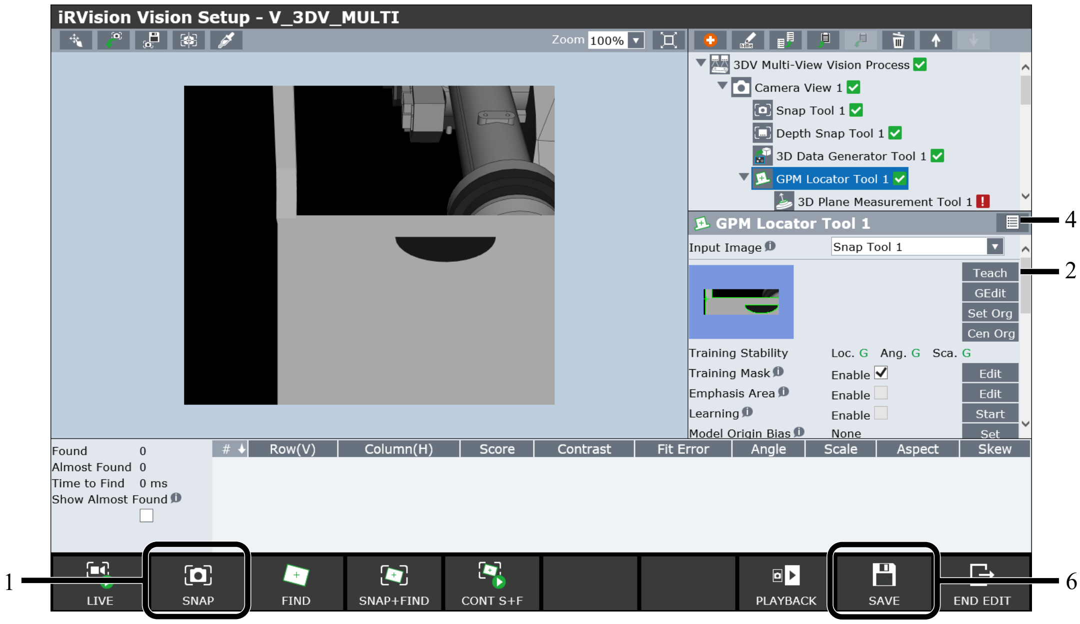
1 Click [SNAP+FIND]. An image is snapped and detection is performed.
2 Check that only necessary 3D points have been found and are shown in light blue.

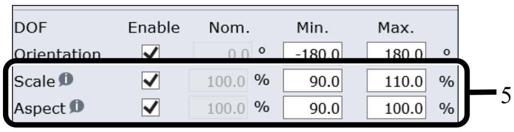
Memo
If many 3D points other than the part are found, it may be improved by checking the [Enable] checkbox in [Table RM.] and adjusting the table height.
If [Table RM.] is enabled, the removed 3D point cloud will be displayed in red.
Check that the areas other than the part are displayed in red.

3.2.4.8 Teaching GPM Locator Tool

Set parameters for 2D measurement (detection of 2D features).
Select [GPM Locator Tool 1] in the tree view, and then set each item.

Setting parameters





DOF	Enable	Nom.		Min.	Max.	
Orientation	✓	0.0	°	-180.0	180.0	°
Scale	✓	100.0	%	90.0	110.0	%
Aspect	✓	100.0	%	90.0	100.0	%

1 Click [SNAP] to snap an image.
2 Click the [Teach] button to teach the model.
The GPM Locator Tool model setup screen appears. Teach 2D features used for position detection. Select features of the model on the same plane to reduce the effects of changes in shape due to parallax. For features that do not need to be included in the model, [Training Mask] can be set to exclude them from the teach model. For details on teaching 2D features, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
In the above example, a portion of the robot is snapped, so you can set up a mask to exclude the robot portion.
3 Check that the pattern that you want to use as the model has been plotted with a green line and that the model origin (green cross) is on the same plane as pattern.

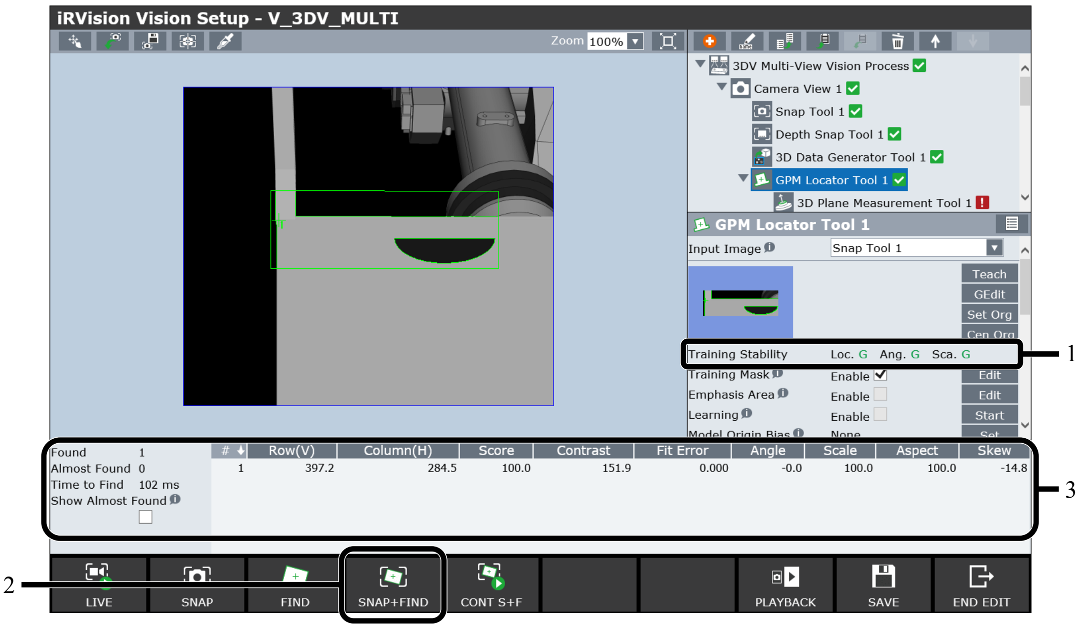
Memo
If the model origin is not on the same plane as the pattern, click the [Set Org.] button and move the model origin onto the same plane as the pattern.

4 Click to switch to advanced mode.
5 Check the checkboxes of [Scale] and [Aspect] in [DOF].

Memo
Change the [Min.] and [Max.] settings for [Orientation], [Scale], and [Aspect] in [DOF] as necessary. If the distance between the camera and the part varies widely, consider expanding the [Scale] search range setting. If the tilt between the camera and the part varies widely, consider expanding the [Aspect] search range setting. Also, if misdetection of the part seems to increase, consider decreasing the search range parameters. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

6 Click [SAVE].

Running a test



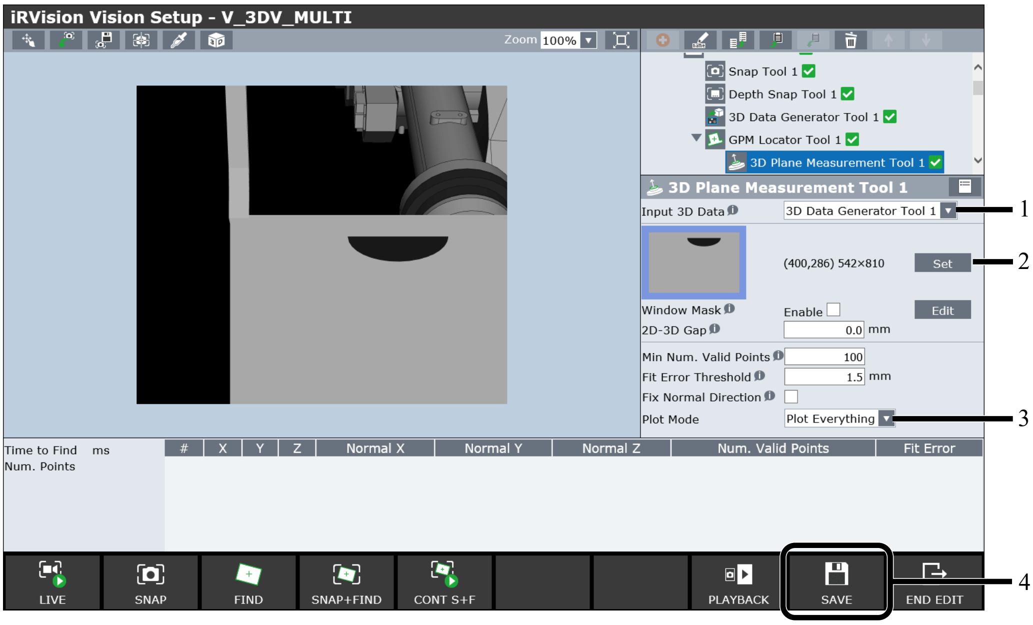
1 Check [Training Stability].
This item provides a guideline indicating whether the position, angle and size are detected correctly in [Training Stability]. Evaluations are indicated with [G] (good), [P] (poor) and [N] (none). [N] indicates that stable detection of the model may be impossible.
In such a case, change the model, or uncheck [Enable] for the parameter in question in [DOF].
2 Click [SNAP+FIND].
An image is snapped and detection is performed.
3 Check measurement results.
Check that the same pattern as the model has been plotted with a green line. Then, check the score, contrast, and other results of the detected model on the test result display area. If the score and contrast values are higher than the set thresholds by at least 10 points, there is no problem.

> **Memo**
> Adjust parameters of the GPM Locator Tool if there is a problem. Some parameters are displayed only in the advanced mode. For this reason, switch the mode as necessary. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3.2.4.9 Setting up 3D Plane Measurement Tool

Set parameters for detecting the plane near the 2D feature position detected with the GPM Locator Tool from 3D points. Select [3D Plane Measurement Tool 1] in the tree view, and then set each item.

Setting parameters



1 Select [3D Data Generator Tool 1] for [Input 3D data].
2 Click the [Set] button.
The green lines shown in the image are the model and the area taught with pattern matching, and the area inside the red frame is the plane measurement area. When the measurement area is taught at first, the red frame will be shown overlapping the green frame, but this can be changed. For details on teaching plane measurement, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
Once the measurement area has been taught, a thumbnail of the image used for teaching appears, and the position and size of the area appear.

> **Memo**
> If the model origin for the GPM Locator Tool is not in the plane you want to measure, change [2D-3D Gap]. If the model origin is above the Z direction as seen from the plane you want to measure, specify a positive value for this setting. For details, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

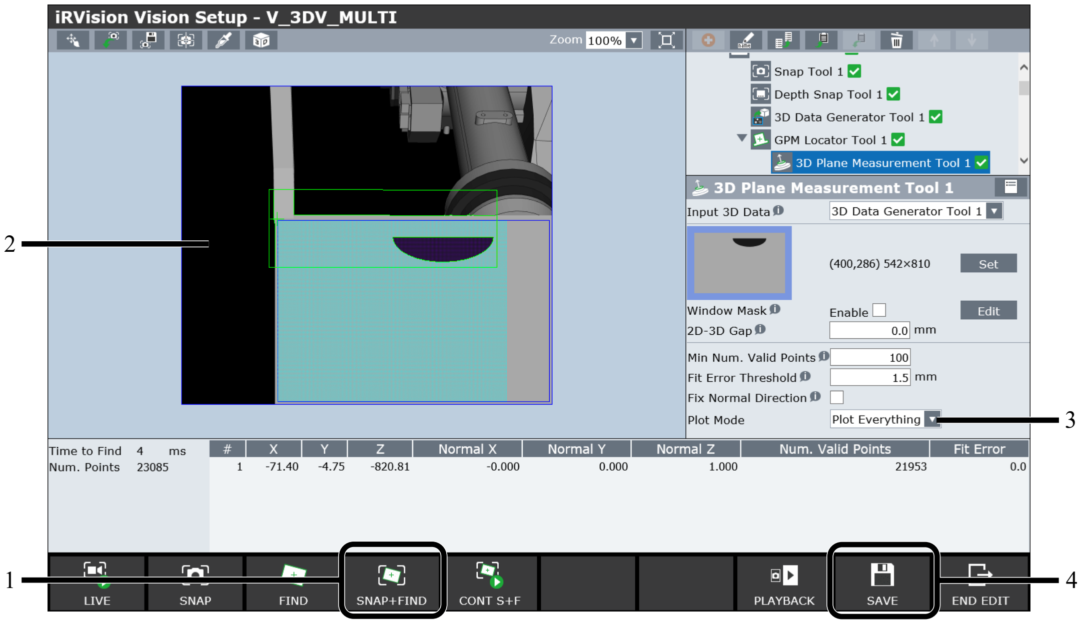
3 Change [Plot Mode] to [Plot Everything].
4 Click [SAVE].

⚠ **CAUTION**

Before setting the 3D Plane Measurement Tool, complete the setting of the GPM Locator Tool. Also, the measurement area must be taught again if the model of the GPM Locator Tool is changed.

Running a test

Check whether the taught area is appropriate. If necessary, adjust parameters to enable stable detection.



1 Click [SNAP+FIND].
  An image is snapped and detection is performed.
2 Check that a light blue plot is displayed on the surface of the part that you want to measure.

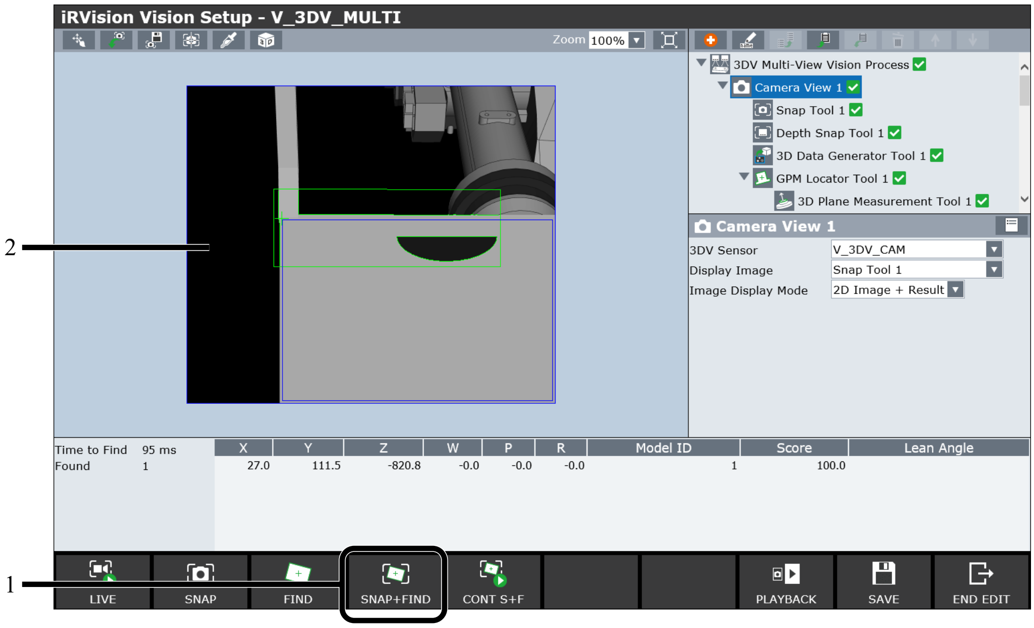
Memo

1 Adjust parameters of the 3D Plane Measurement Tool if there is a problem. For example, if a light blue plot is displayed on a surface other than the one that you want to measure, teach [Window Mask]. Also, some parameters are displayed only in advanced mode. For this reason, switch the mode as necessary. For details, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”
2 Change the measurement area to match the shape of the part.

3 If there is no problem with the test run, change the option for [Plot Mode] to [Plot Measurement Area].
4 Click [SAVE].

3.2.4.10 Running a test for Camera View 1

After setting all child tools for Camera View 1, select [Camera View 1] in the tree view, and then perform a test run to check whether detection with Camera View 1 is performed correctly.



1 Click [SNAP+FIND].
An image is snapped and detection is performed.

2 Check whether detection was successful.
If the features you want to detect on the screen are plotted with a green line, detection completed without problems.

> ⚠ **CAUTION**
> From here on, do not move the part until teaching for the robot operation while holding the part at the reference position with the TP program for tool offset is finished.

> **Memo**
> 1 The reference position in “3DV Multi-View Vision Process” in “Setup: 3.2.4.12 Setting reference position” is set using the detection results from the camera views. Therefore, if detection with the camera view is not successful, vision process setup is not complete.
> If detection with the camera view is unsuccessful, review the parameters for the child tools, and check whether detection is performed correctly again.
> 2 The value for [Lean Angle] is not displayed in the result display area at this stage. It will be displayed after the reference position is set in “Setup: 3.2.4.12 Setting reference position.”

3.2.4.11 Setting up Camera Views 2 to 4

After setting up Camera View 1, set up Camera Views 2 to 4 using the same procedures.
The procedures are the same, but it is recommended that you move the robot and change the measurement position for each camera view. This is because the accuracy of the offset motion is improved by separating the part teaching positions as much as possible for each camera view.

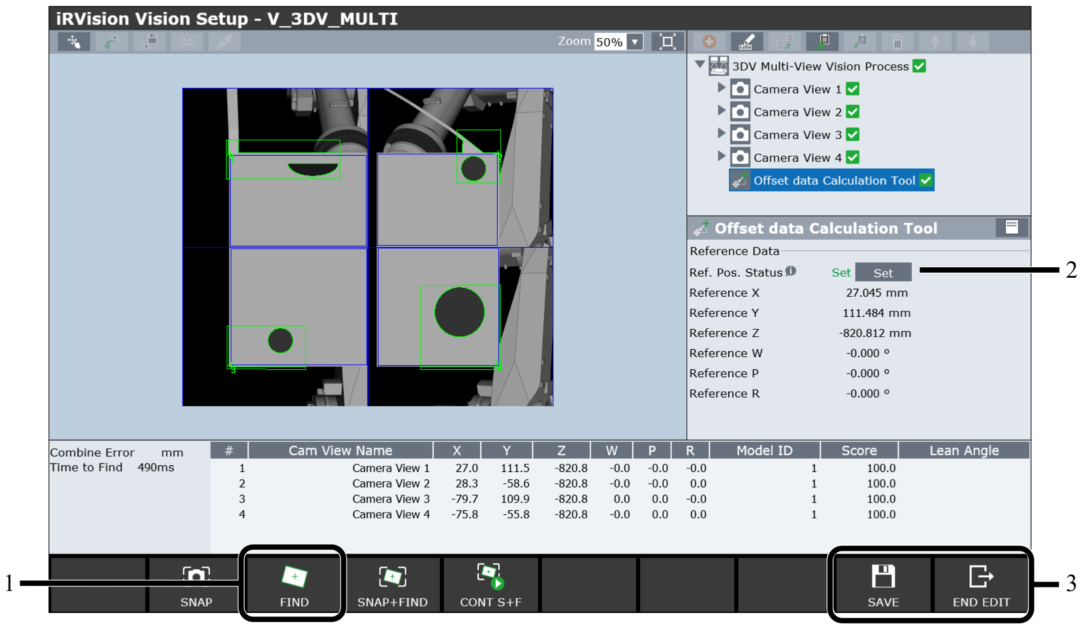
Memo

1 When storing the camera view detection position in a position register, it is convenient to store each camera view's position in a different position register. If you are creating a TP program based on the example in "Setup: 3.2.5 Creating and Teaching a TP Program", set up the position registers based on the setting example too.
2 In the initial state, four camera views are available on the assumption that four points will be measured, but if it is impractical to measure four points, you can delete one of the camera views. However, Camera View 1 cannot be deleted.
3 When setting up Camera Views 2 to 4, snap after you have moved the robot to each of the measurement positions. Be careful not to continue setup with the same image snapped from another camera view.

3.2.4.12 Setting reference position

Here, place a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.

Select [Offset data Calculation Tool] in the tree view, and then set each item.



1 Click [FIND] to detect the part.

> ⚠ **CAUTION**
> Do not click [SNAP] or [SNAP+FIND] at this point. If you make a snap, the snap images of all camera views will be reacquired at the current position, and the reference position will not be set correctly.
> If you mistakenly click [SNAP] or [SNAP+FIND], move the robot to each camera view's measurement position, and repeat the test run for each camera view again.

2 Check that the part has been found correctly, and click the [Set] button of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

3.2.5 Creating and Teaching a TP Program

Create a TP program for the 3D tool offset system by measuring multiple points using the 3DV Sensor. Below is an example TP program and an explanation of the position registers.

Position registers

PR [1: Home]	Home position. The robot's waiting position and posture when it is not doing any work.
PR [2: Search1]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 1.
PR [3: Search2]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 2.
PR [4: Search3]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 3.
PR [5: Search4]	The detection position. The robot's position and posture when the sensor has found the part in Camera View 4.
PR [9: Place Approach]	The placement approach position.
PR [10: Place]	The placement position.
PR [11: Place Retract]	The place retraction position. It can be the same position and posture as PR[9].

```
 1:  UFRAME_NUM=1
 2:  UTOOL_NUM=1
 3:  J PR[1:Home] 30% FINE
 4:
 5:  LBL[10]
 6:  !SEARCH 1
 7:  J PR[2:Serach1] 100% FINE
 8:  WAIT    .30(sec)
 9:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[1]
10:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[1]
11:  IF R[14]<1,JMP LBL[999]
12:
13:  !SEARCH 2
14:  J PR[3:Serach2] 100% FINE
15:  WAIT    .30(sec)
16:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[2]
17:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[2]
18:  IF R[14]<1,JMP LBL[999]
19:
20:  !SEARCH 3
21:  J PR[4:Serach3] 100% FINE
22:  WAIT    .30(sec)
23:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[3]
24:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[3]
25:  IF R[14]<1,JMP LBL[999]
26:
27:  !SEARCH 4
28:  J PR[5:Serach4] 100% FINE
29:  WAIT    .30(sec)
30:  VISION RUN_FIND 'V_3DV_MULTI' CAMERA_VIEW[4]
31:  VISION GET_NFOUND 'V_3DV_MULTI' R[14] CAMERA_VIEW[4]
32:  IF R[14]<1,JMP LBL[999]
33:
34:  !GET OFFSET DATA
35:  VISION GET_OFFSET 'V_3DV_MULTI' VR[1] JMP LBL[999]
36:
37:  !PLACE
38:  L PR[9:Place Approach] 800mm/sec CNT100 VOFFSET,VR[1]
39:  L PR[10:Place] 200mm/sec FINE VOFFSET,VR[1]
40:  !Insert program instruction to release the part
41:  CALL ...
42:  L PR[11:Place Retract] 800mm/sec CNT100 VOFFSET,VR[1]
43:  JMP LBL[10]
44:
45:  !ERROR
46:  LBL[999]
```

- Line 2: Specify the tool frame number set in “3.2.3 Tool Frame Setting.”
- Line 8: Wait for robot-vibration to reduce.
- Line 9: Execute measurement of Camera View 1.
- Line 10: Get the number of found for Camera View 1.
- Line 11: Jump to the last row when not found for Camera View 1.
- Line 35: Get the offset data in the measurement results (jump to the last row when failed to get).
- Line 39: Move to the part placement position.

Memo

For the CALL command on line 41, specify the command to release the part.

3.2.6 Checking Robot Offset Operation

Check that a part gripped by the robot can be detected and placed precisely.
The detection results and offset data acquisition results from the vision command can be checked on the vision runtime screen. For details about the vision runtime screen, refer to "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

> ✐**Memo**
> Here, you need to move the part to check the operation. Move the part so that the part features taught for each camera view are within the field of view for each camera view, and then check operation.

- Grasp the part on the reference position, find it and check the handling accuracy. If the handling accuracy is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation, find it and check the handling accuracy.
- Rotate the part, find it and check the handling accuracy. If the part near the reference position can be handled accurately but the accuracy decreases as the part rotates, the settings of the calibration grid and of the frame used for offset may not have been performed accurately. If you set the frame with a pointer tool, check the accuracy of touch-up and retry calibrating the 3DV Sensor.
- Change the distance from the camera to the part and find it while gripping it to check the handling accuracy.
- Tilt the part and find it while gripping it to check the handling accuracy.

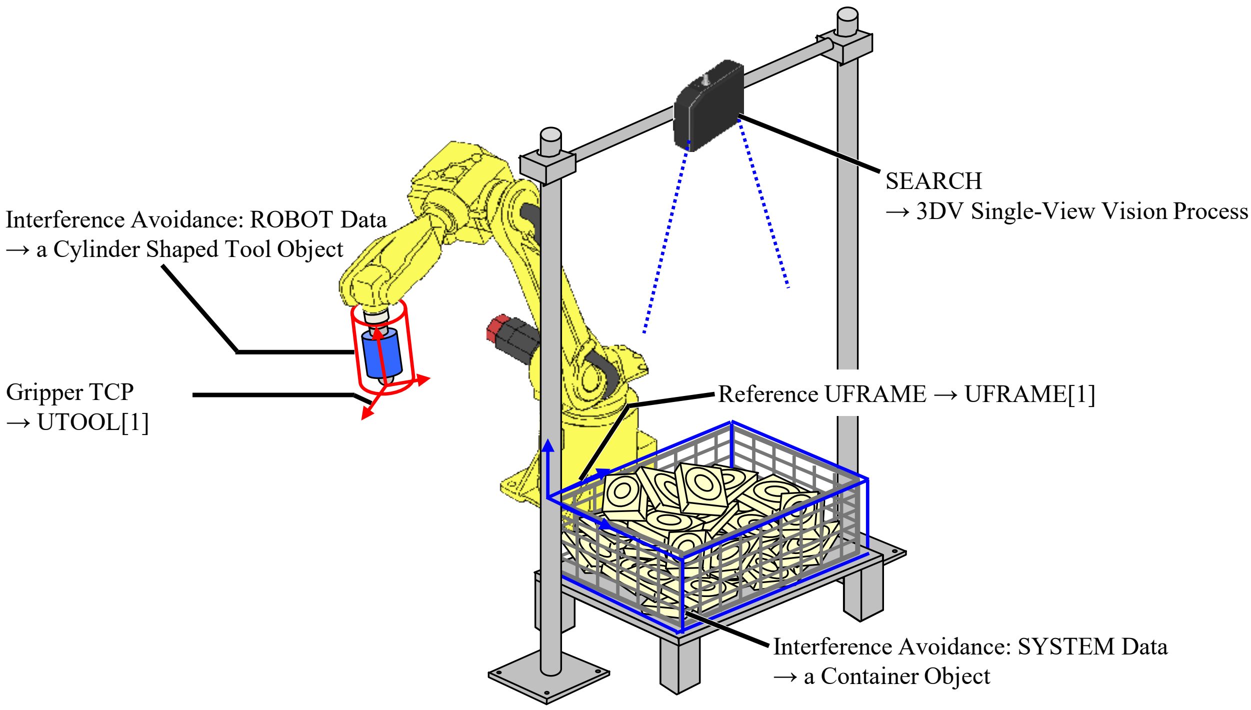
> ✐**Memo**
> Depending on the shape of the part and the gripper, it may not be possible to grip the part in the states described above. If this is the case, the check is not required.

4 BIN PICKING SYSTEM

This chapter explains the setup procedure of the Bin Picking system using a fixed camera in the figure below as an example.

> **Memo**
> This chapter describes the screens and operations in the simple mode unless otherwise noted. For details on the Simple Mode and Advanced Mode, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

4



Example of Bin Picking system configuration

4.1 INSTALLATION AND CONNECTION OF 3DV SENSOR

Installation of the 3DV Sensor

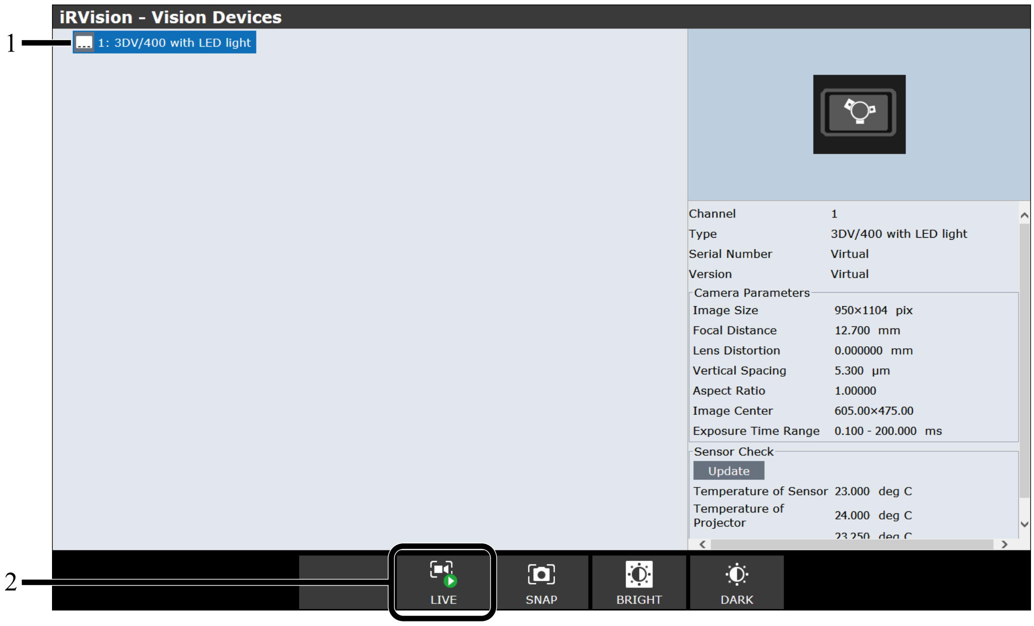
Install the 3DV Sensor on the camera mount.

Connecting the 3DV Sensor

Connect the 3DV Sensor to a robot controller.

Checking the connection of the 3DV Sensor

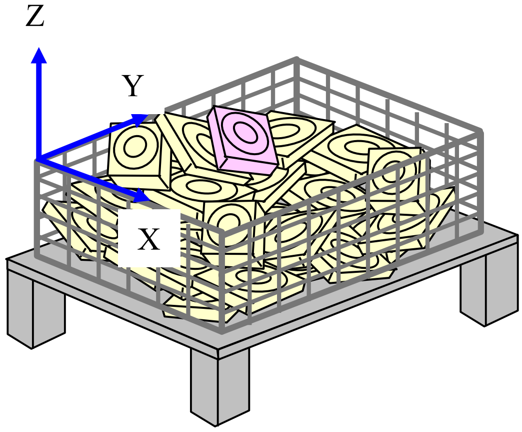
Open Vision Devices and check that the 3DV Sensor is connected according to the following procedure.



1 On the ROBOT Homepage, select [*i*RVision] →[Vision Devices], and select the connected 3DV Sensor on the Vision Devices screen.
2 Click [LIVE] and check that continuously snapped images are displayed.

4.2 USER FRAME SETTING

Set the user frame that becomes the reference frame for an offset calculation and interference avoidance calculation. Set it on the upper opening of the container as shown in the figure below. For how to set up the user frame, refer to “Know-How: 1 FRAME SETTING.”



Example of user frame setup

Here, set the user frame to UFRAME [1] as described in the figure ‘Example of Bin Picking system configuration’ at the beginning of this chapter.

4.3 CREATING AND SETTING UP 3DV SENSOR DATA

To use the 3DV Sensor, the 3DV Sensor must be set using a calibration grid.
Set the mounting position of the fixed camera according to the procedures described in “Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA.”

4.4 TOOL FRAME SETTING

Set a tool frame in the center of the end of the gripper claw or the pad to pick up a part. This frame is useful for accurately moving the TCP of the gripper to the part gripping position.
The Z-axis of this frame should be set along the direction in which the gripper approaches the part to be picked up. The positive direction of the Z-axis should be reversed compared to the direction in which the gripper approaches a part. Therefore, change the direction to W=180 by the direct list method immediately after teaching a TCP.
Here, set the TCP of the gripper to UTOOL [1] referring to the figure ‘Example of Bin Picking system configuration’ at the beginning of this chapter. For how to set up the tool frame, refer to “Know-How: 1 FRAME SETTING.”

4.5 SETUP OF INTERFERENCE AVOIDANCE DATA

Interference Avoidance data consists of Interference Setup (System) data, Interference Setup (Robot) data, and Interference Setup (Condition) data. Set up the necessary type of Interference Avoidance data. This system comes with pre-installed Interference Avoidance data. By editing the sample settings, you can quickly prepare the data. For the operation of interference avoidance and description of each item, refer to the description on interference avoidance in “*i*RVision Bin Picking Application OPERATOR’S MANUAL B-83914EN-6.”

4.5.1 Setup of Interference Setup (System) Data

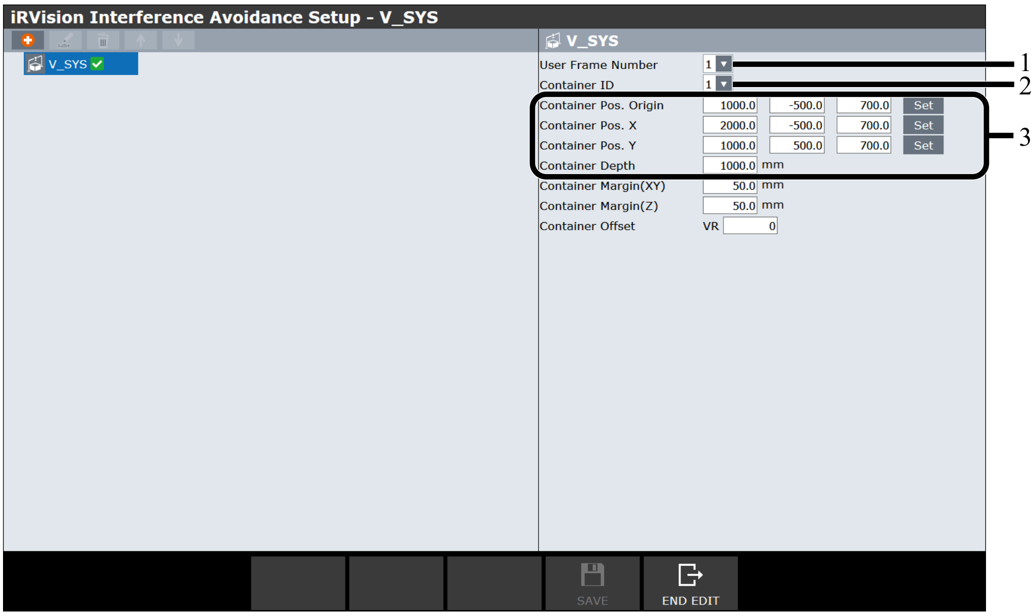
Set Interference Setup (System) data for interference avoidance.

Creating Interference Setup (System) data

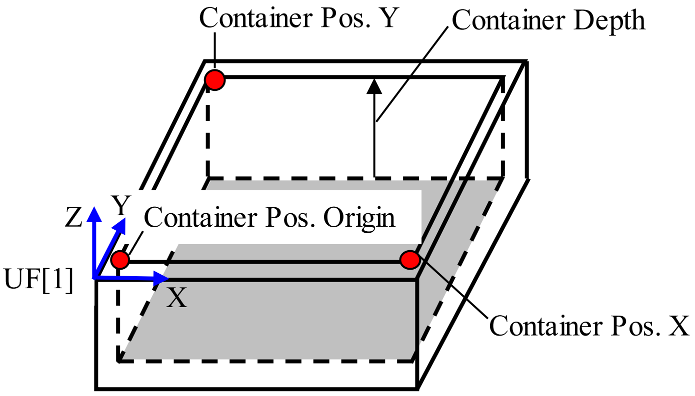
On the ROBOT Homepage, select [*i*RVision] then [Interference Avoidance Setup]. The interference avoidance data list screen appears. Select [V_SYS] on the interference avoidance data list screen and click [EDIT] to set Interference Setup (System) data.

Setting a container object

Set the user frame and a container object that form the basis for interference avoidance position calculation according to the following procedures.



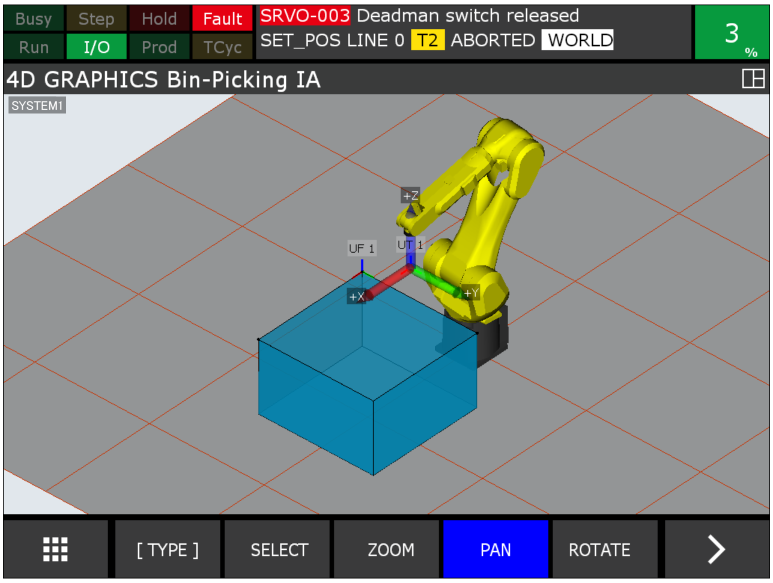
1 Select UF[1] for [User Frame Number].
2 Select [1] for [Container ID].
3 Set the container’s position and size for [Container Pos. Origin], [Container Pos. X], [Container Pos. Y], and [Container Depth].
   Touch up each of the positions shown in the following figure with the pointer tool mounted on the robot, and set it by clicking the relevant [Set] button.
   Set the value for [Container Depth] by measuring the depth of the container in the following figure.



Setting up a container

Checking via 4D Graphics

After setting up the container object, check that the settings have been made correctly on the 4D Graphics page on the teach pendant.
On the teach pendant, select the [MENU] key, [Next], [4D GRAPHICS], then [4D Display], and select F1[TYPE], then [4D Bin Picking IA]. In addition to the robot, the set container object is displayed in 3D graphics.



Check that the position and size of the container are correct.

4.5.2 Setup of Interference Setup (Robot) Data

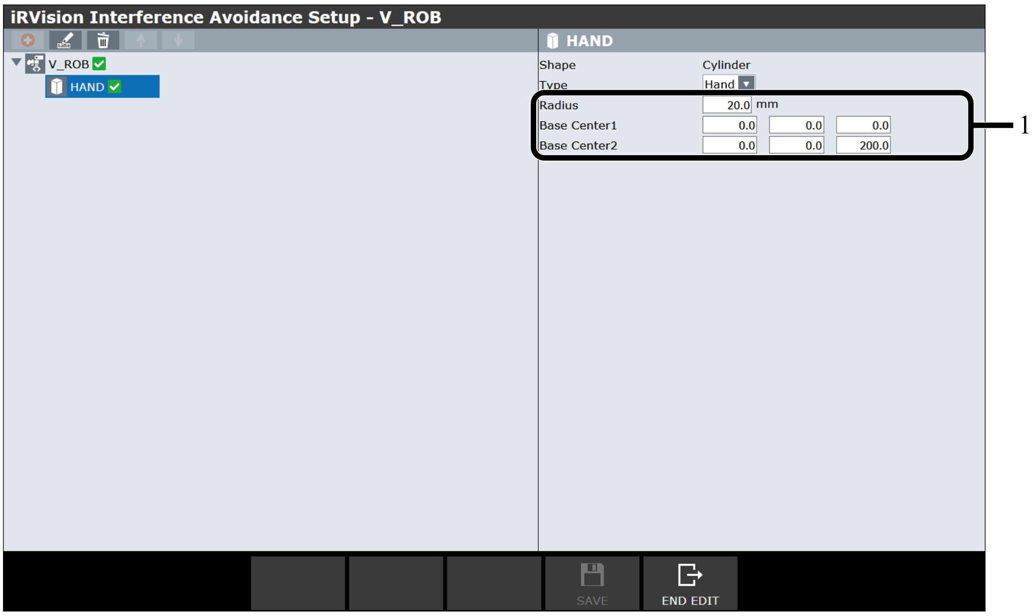
Set Interference Setup (Robot) data for interference avoidance.
On the ROBOT Homepage, select [*i*RVision] then [Interference Avoidance Setup]. The interference avoidance data list screen appears.

Setup of Interference Setup (Robot) data

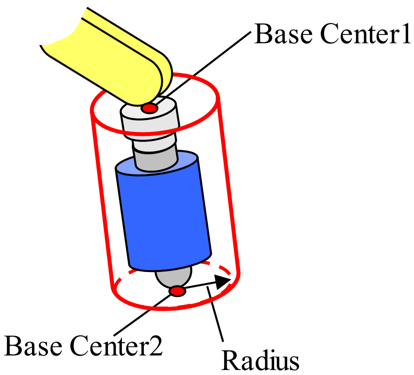
Select [V_ROB] on the interference avoidance data list screen and click [EDIT] to set Interference Setup (Robot) data.
First, set a tool object according to the following procedures.

Setting a tool object

Select [HAND] in the tree view on the Interference Setup (Robot) screen, and set a tool object according to the following procedures.



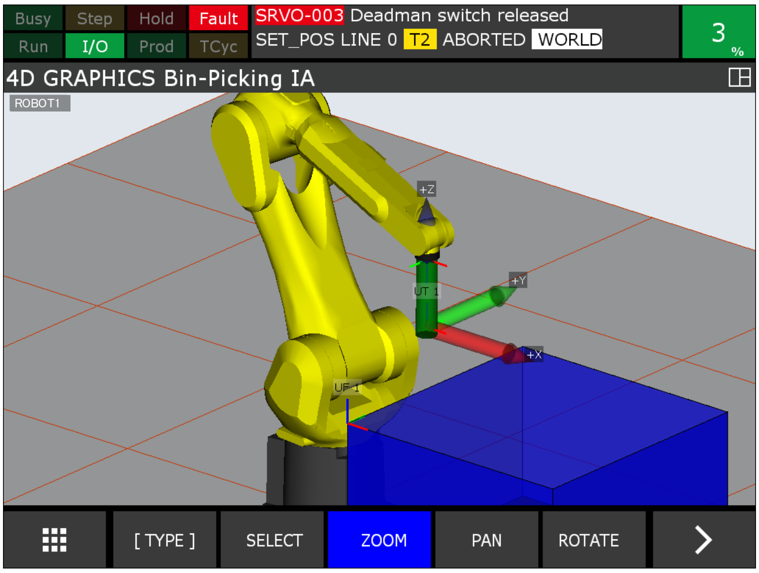
1 Set the size and positions in the following figure for [Radius], [Base Center1], and [Base Center2].



Checking via 4D Graphics

After setting the tool object, check that the setting has been made correctly on the 4D Graphics page on the teach pendant.

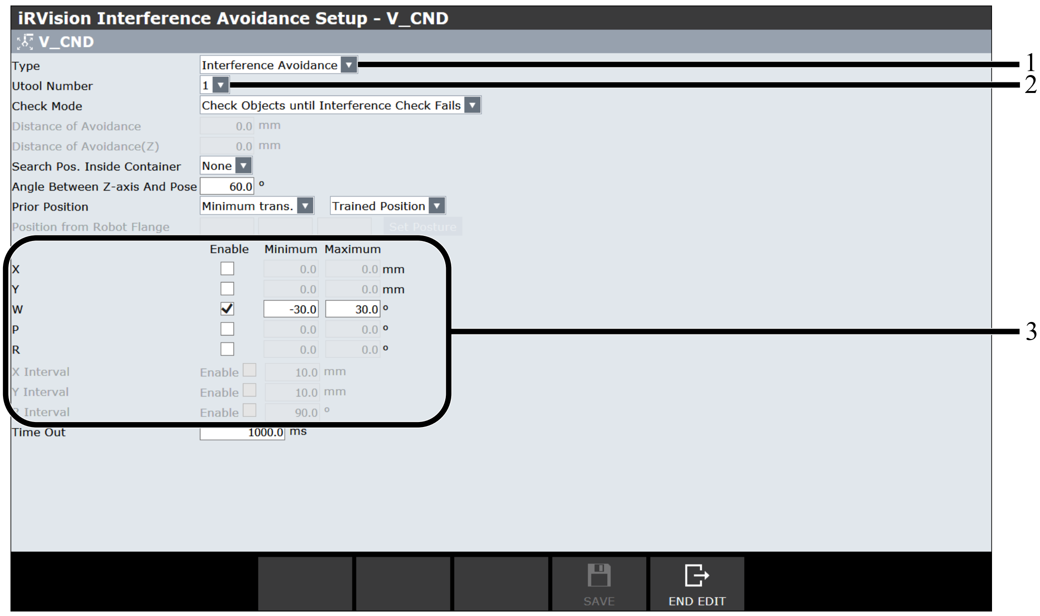
On the teach pendant, select the [MENU] key, [Next], [4D GRAPHICS], then [4D Display], and select F1[TYPE], then [4D Bin Picking IA]. In addition to the robot, the set tool object is displayed in 3D graphics.



Check that the position and size of the tool object are correct.

4.5.3 Setup of Interference Setup (Condition) Data

Set Interference Setup (Condition) data for interference avoidance.
Select [V_CND] on the interference avoidance data list screen and click [EDIT] to display the Interference Setup (Condition) data setting screen.
Set the parameters according to the following procedures.



1 Select [Interference Avoidance] for [Type].
2 Select Utool [1] for [Utool Number].
3 Set the range of interference avoidance.
Set the range −30 to 30 degrees in the W direction as the range in which interference can be avoided. Change the range according to the part and the gripper.

4.6 SETTING UP VISION PROCESS

Set up a “3DV Single-View Vision Process.”
This system has a pre-installed sample vision process. The following explains the procedure for editing the settings based on that sample.

The Bin Picking system using a fixed camera mainly uses the following two types of detection methods:

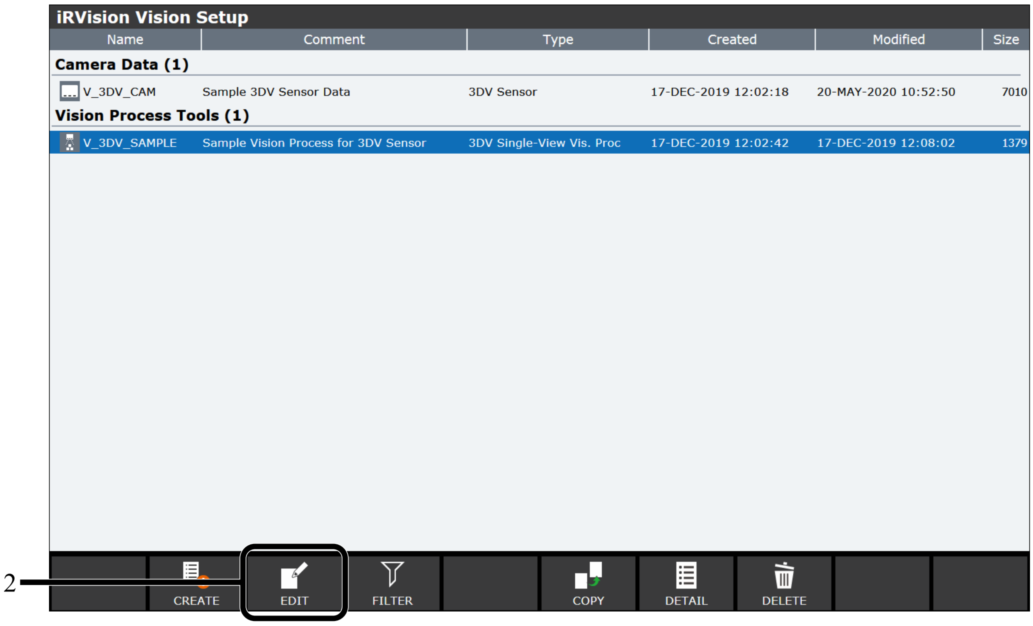
- 3D Blob Locator Tool
- GPM Locator Tool + 3D plane measurement command tool

This section explains the settings for the former method.

4.6.1 Editing Vision Process

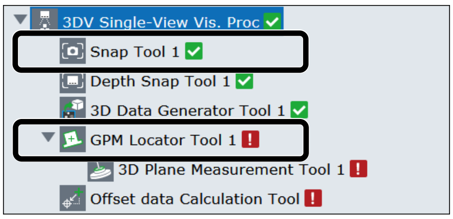
Select the sample vision process and open the edit screen.

1 Click [V_3DV_SAMPLE] in the [Vision Process Tools] category on the vision data list screen.



2 Click [EDIT].
The vision process setup screen appears.

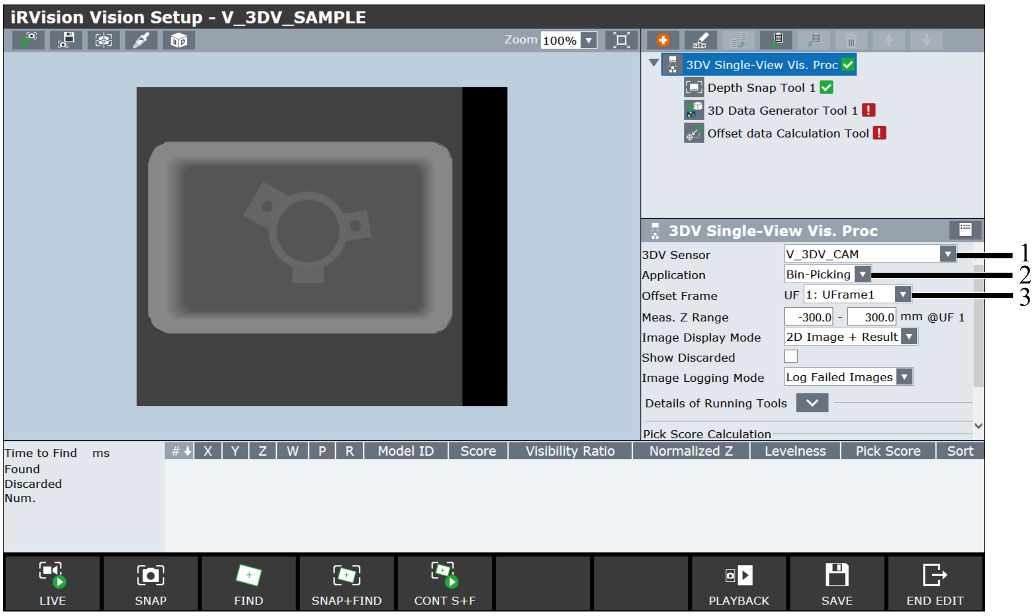
3 Select an unnecessary command tool from the tree view of the vision process and click the button to delete it.
For the SEARCH Vision Process of the Bin Picking system to be set up, delete [Snap Tool 1] and [GPM Locator Tool 1].



Memo

1 For the sample vision process, the Snap Tool, Depth Snap Tool, 3D Data Generator Tool, GPM Locator Tool, 3D plane measurement command tool, and offset data calculation tool are placed by default.
2 Deleting the GPM Locator Tool deletes the 3D plane measurement command tool at the same time.
3 Since the offset data calculation tool cannot be deleted, leave it as unset.

4.6.2 Setting Parameters of Vision Process

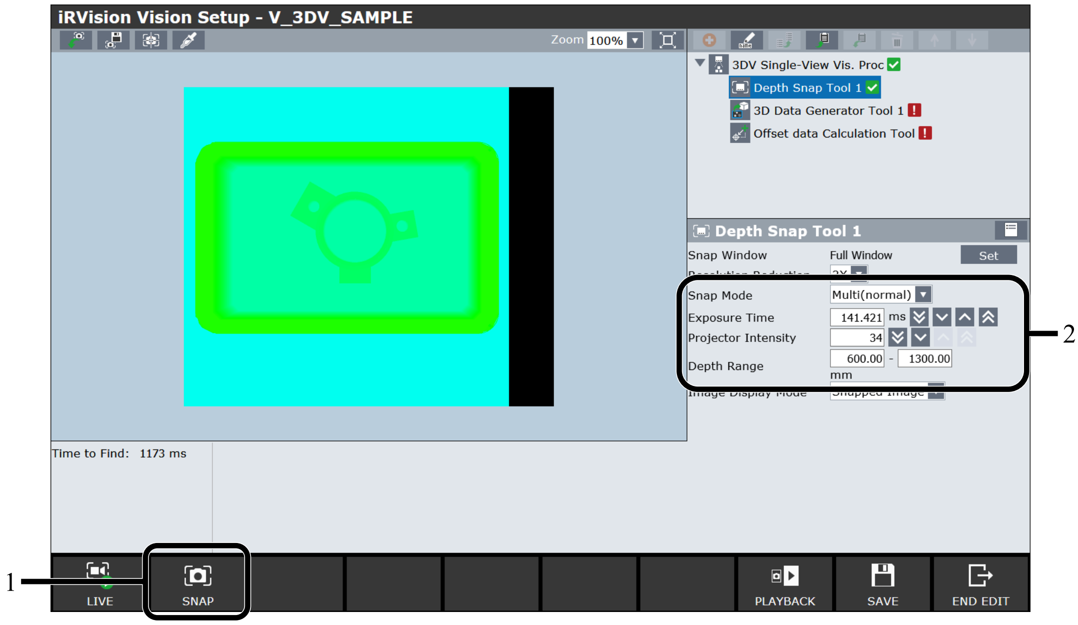


1 Select [V_3DV_CAM] from the [3DV Sensor] drop-down box.
2 Select [Bin-Picking] from the [Application] drop-down box.
3 Select the user frame number set as [Offset Frame] from the drop-down box.
Offset frame is the user frame used for calculation of offset.
Select the user frame number set in “Setup: 4.2 Setting User Frame.”

4.6.3 Teaching Depth Snap Tool

Select [Depth Snap Tool 1] in the tree view, and then set each item.

Setting parameters



1 Click [SNAP].
2 Adjust each parameter so that measurement omission (black area) will be reduced.
For details on each parameter, refer to “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”
Repeat the procedure starting from step 1 until the parameters are adjusted appropriately.

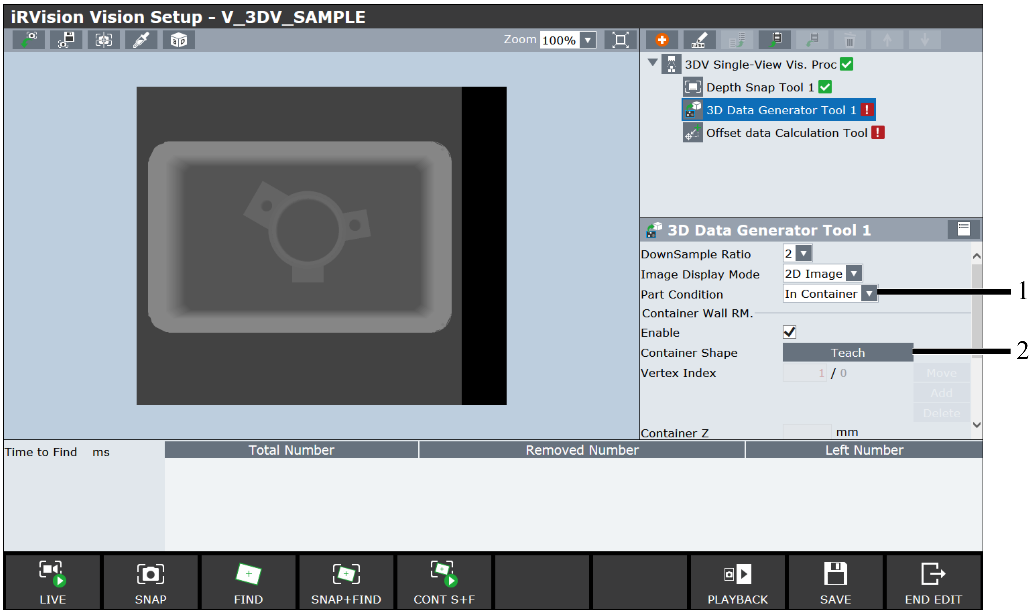
Memo

Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor’s field of view. For this reason, the right edge of the sensor’s field of view may remain a black area. For details, refer to “Setup: 2.4 3D VISION SENSOR” in “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”

4.6.4 Setting Parameters of 3D Data Generator Tool

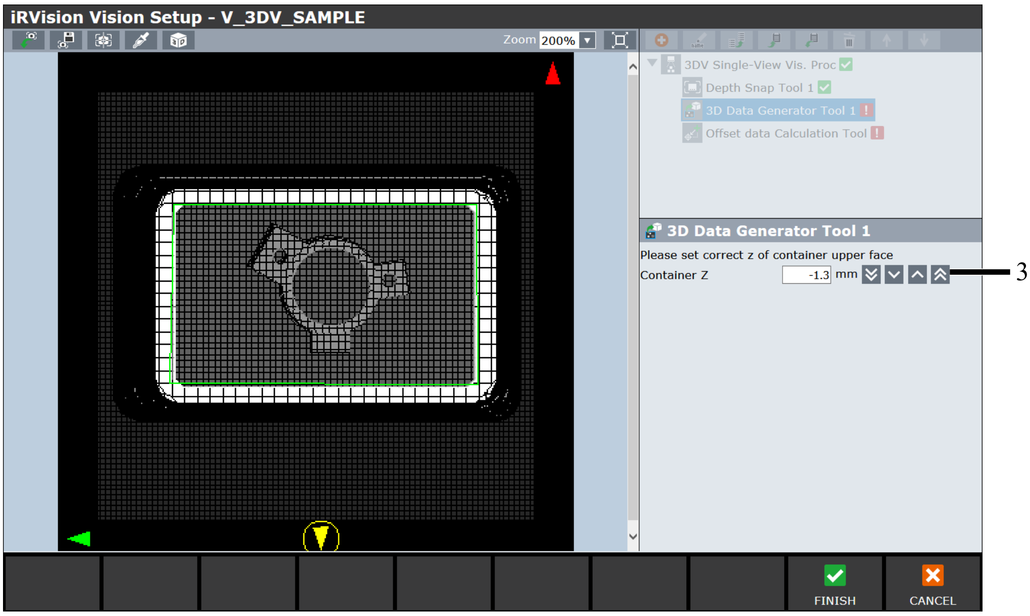
Select [3D Data Generator Tool1] in the tree view, and then set each item.

Setting parameters

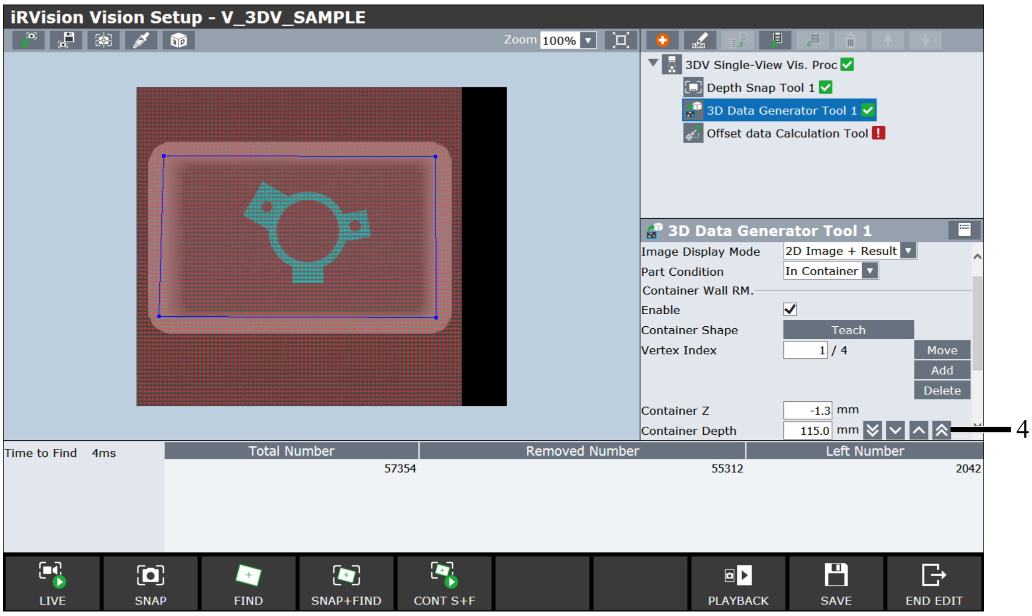


1 Select [In Container] from the [Part Condition] drop-down box.

2 Click the [Teach] button of [Container Shape].
The container shape teaching screen for [3D Data Generator Tool] appears.
Move ⌖ displayed on a 2D image to the position of a vertex (corner) of the container rim and click [OK].
Then, the position of the vertex is set and ⌖ is displayed again. Move ⌖ to the position of the next unset vertex of the container and click [OK].
Repeat this operation. When finished, select the position of the first vertex with ⌖.



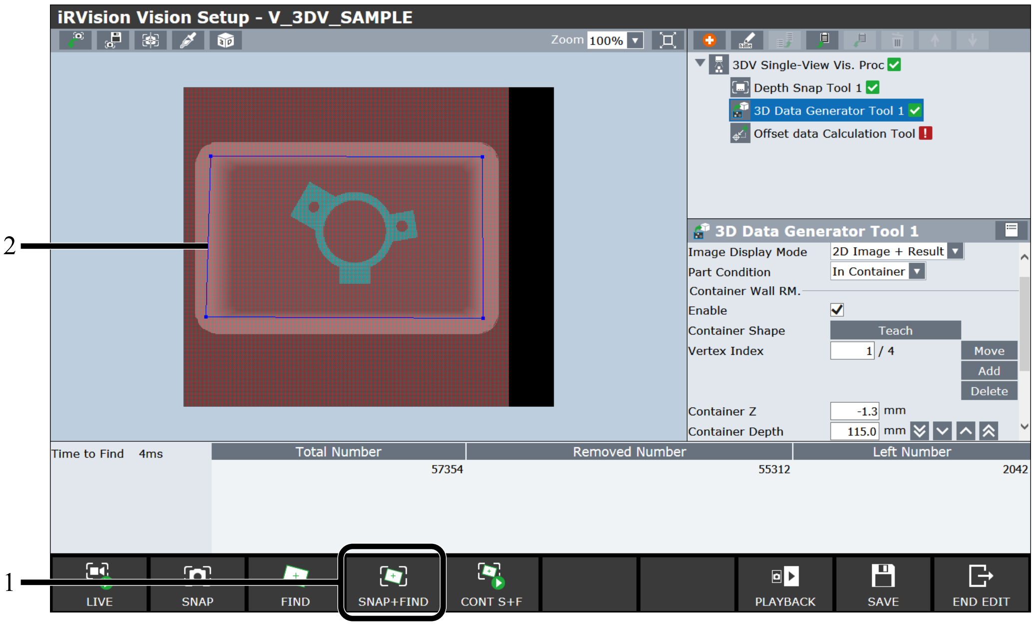
3 Set [Container Z] (unit: millimeters (mm)).
This value is the height of the top of the container from the XY plane of [Offset Frame].
[Container Z] is automatically calculated from the 3D points near the taught container shape.



4 Set the depth from the top of the container for [Container Depth].
When [Container Depth] is changed, the result of 3D points in the container being removed (red points in the figure) is displayed. Adjust [Container Depth] based on the result.

Running a test

Check that unnecessary 3D points for part detection have been removed correctly.



1 Click [SNAP+FIND]. An image is snapped and detection is performed.
2 Check that unnecessary 3D points for part detection have been removed correctly.
The area displayed in red is a removed 3D point group. Check whether the area other than the part is displayed in red.

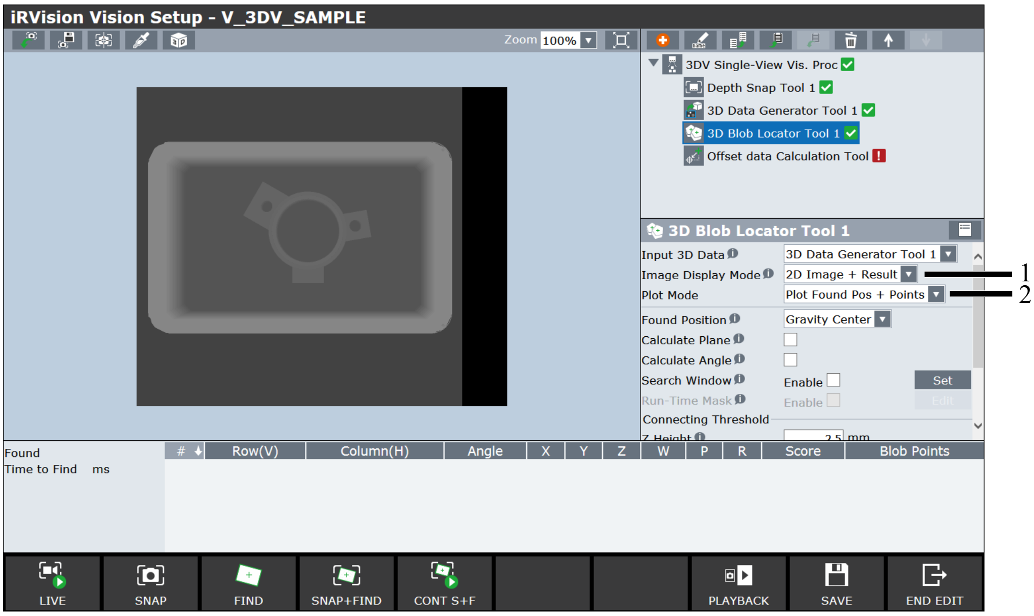
4.6.5 Setting Parameters of 3D Blob Locator Tool

Create a new 3D Blob Locator Tool for the vision process according to the following procedure.

1 Select [3DV Single-View Vis. Proc] in the tree-view and click the button.
A pop up to create a new vision tool appears.
2 Click [3D Blob Locator Tool] in [Type].
[3D Blob Locator Tool 1] is automatically set for [Name], but no change is needed here.
3 Click [OK].
3D Blob Locator Tool has been added.

Select [3D Blob Locator Tool 1] in the tree view, and then set each item.

Setting parameters

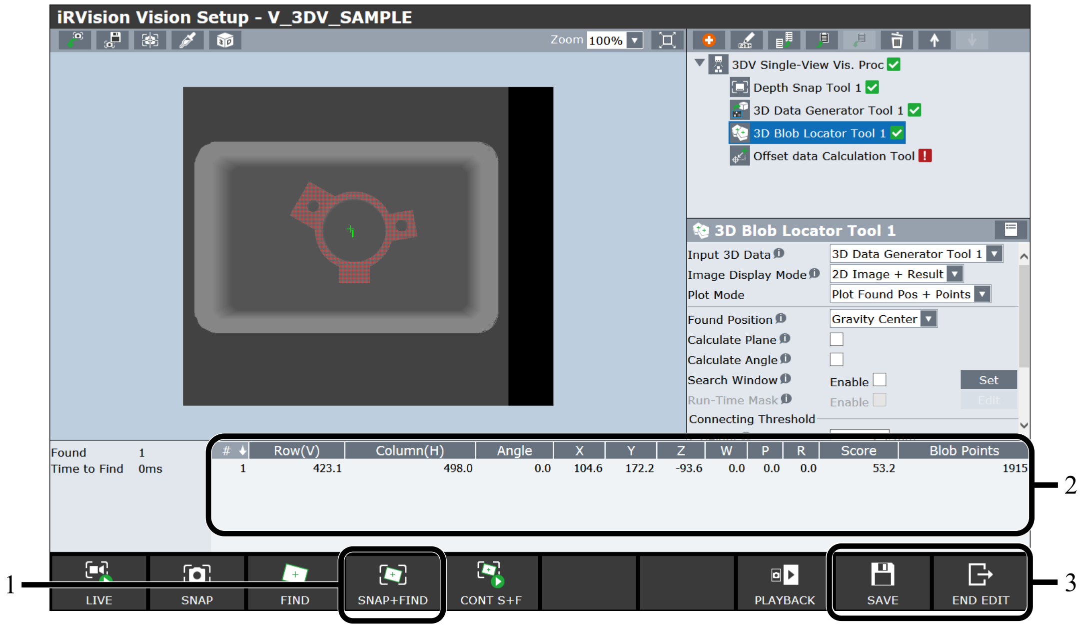


1 Select the tool to obtain 3D data for [Input 3D data].
Since [3D Data Generator Tool] is automatically selected when you newly create it, it is unnecessary to change it in the system to be started here.
2 Select [Plot Found Pos + Points] from the [Plot Mode] drop-down box.

For details on each parameter, refer to the description of commands in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Running a test

Check whether the part is correctly detected. Adjust each parameter to enable stable detection.



1 Click [SNAP+FIND].
An image is snapped, and detection is performed.

2 Check measurement results.
Check that unnecessary 3D points for part detection have been removed correctly.

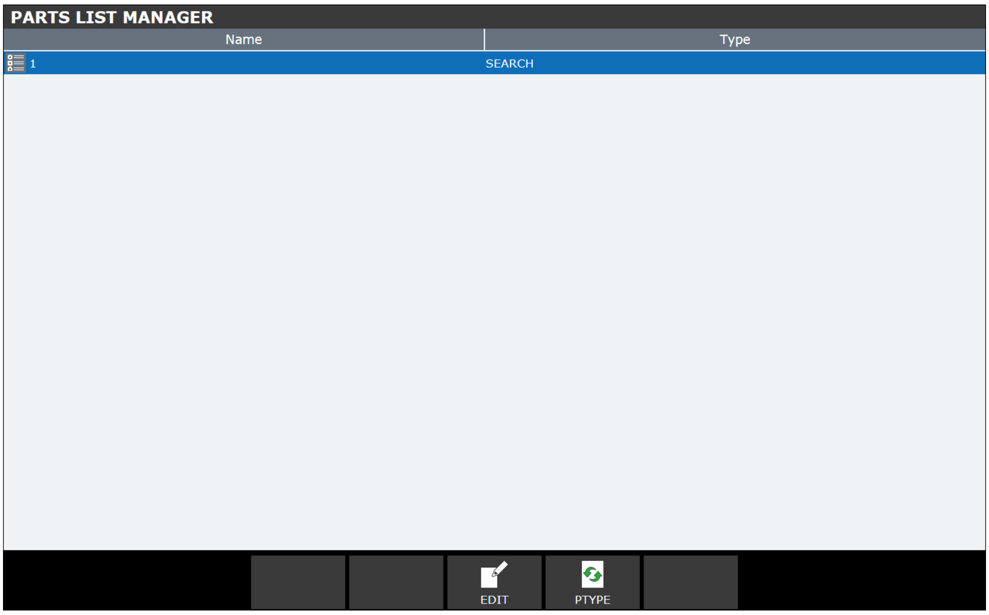
3 Click [SAVE] and then [END EDIT] if there is no problem with the detection results.

4.7 SETUP OF PARTS LIST MANAGER

Set the Parts List Manager.
On the ROBOT Homepage, select [*i*RVision], then [Parts List Manager], and the Parts List Manager list screen appears. For the operation of Parts List Manager and a description of each item, refer to the description on interference avoidance in "*i*RVision Bin Picking Application OPERATOR'S MANUAL B-83914EN-6."

4.7.1 Selection of Parts List

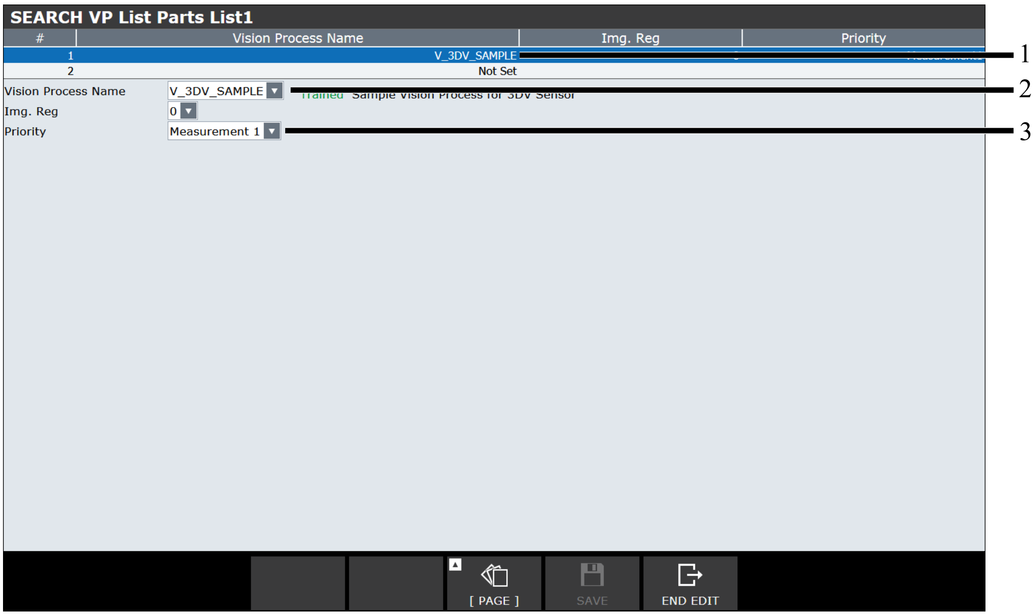
On the Parts List Manager list screen, select the pre-installed sample parts list and click [EDIT].



For details on creating a new parts list or changing the parts list type to [SEARCH + FINE], refer to "*i*RVision Bin Picking Application OPERATOR'S MANUAL B-83914EN-6."

4.7.2 Setting SEARCH VP List

Set the created SEARCH vision process to the SEARCH VP List.
On the Parts List Manager data list screen, select the parts list to edit and click [EDIT]. The SEARCH VP List edit screen will appear. Set the parameters according to the following procedures.

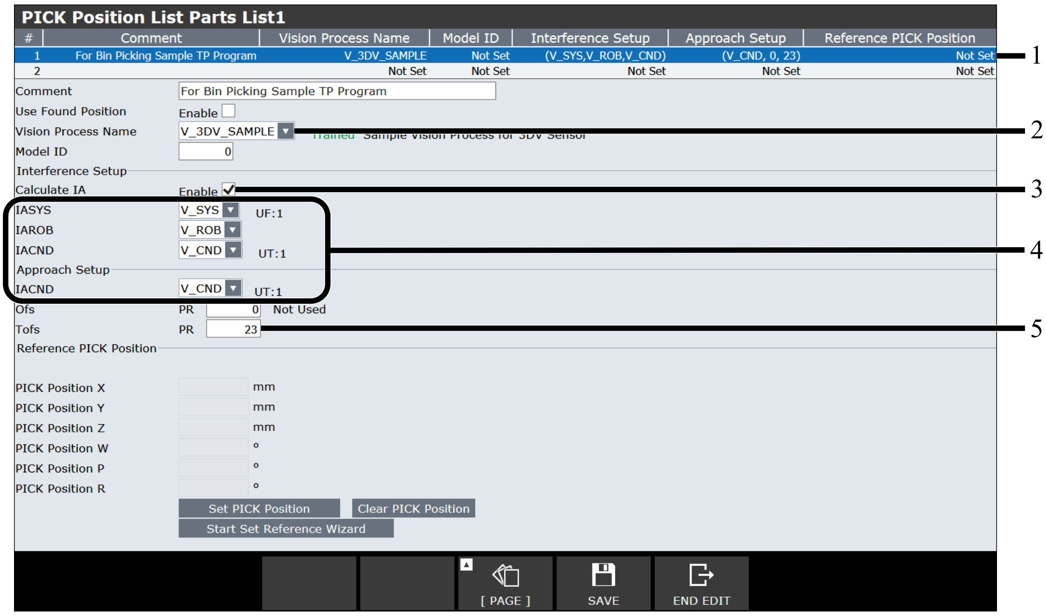


1 Select the first line in the SEARCH VP List.
2 For [Vision Process Name], select the created vision process for SEARCH Vision Process.
3 Select [Measurement 1] for [Priority].

4.7.3 Setting PICK Position List

Teach the reference PICK position and set it to the PICK Position List.

On the Parts List Manager data list screen, select the parts list to edit and click [EDIT]. The SEARCH VP List edit screen will appear. Select [PAGE], then [PICK Position List]. On the PICK Position List edit screen, set the following.

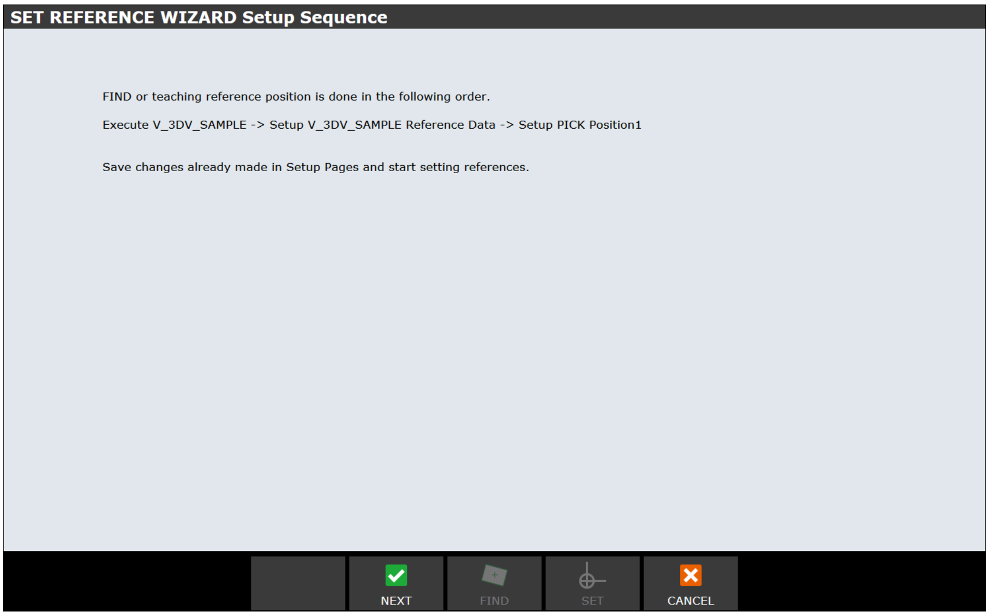


1 Select the first line in the PICK Position List.
2 For [Vision Process Name], select the created vision process for SEARCH Vision Process.
3 Check the [Enable] checkbox in [Calculate IA].
4 Select the created Interference Avoidance data.
5 For [Tofs] in [Approach Setup], set the number of the position register used for approach position calculation and to which the tool offset value from the PICK Position is set.
Here, the tool offset is assumed to be set to PR[23], and (0.0, 0.0, 100.0, 0.0, 0.0, 0.0), for example, is set in Cartesian coordinate system format.

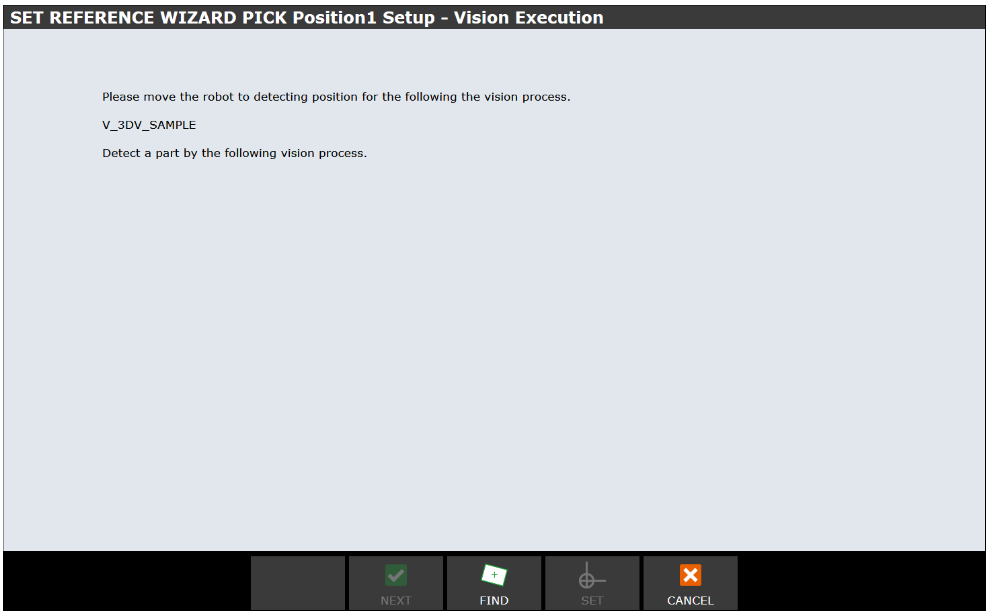
4.7.4 Setting PICK Position with Set Reference Wizard

Set the reference PICK position and SEARCH Vision Process reference data.

1 When the [Start Set Reference Wizard] button is clicked on the PICK Position List edit screen, the following screen appears. Check the setup procedure and click [NEXT].

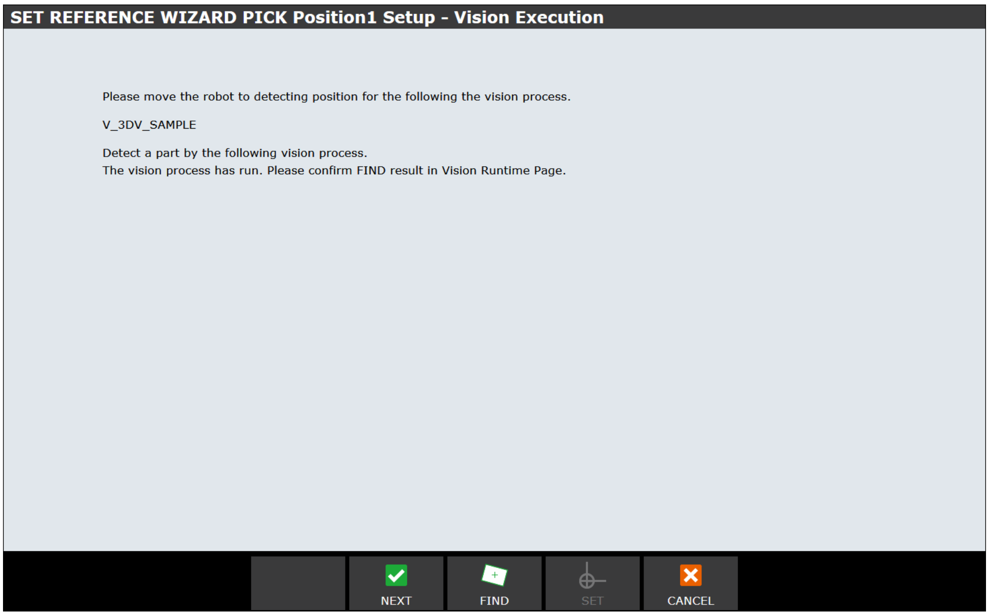


2 When the following screen for finding a vision process appears, move the robot out of the container by jogging it, for example, and click [FIND].

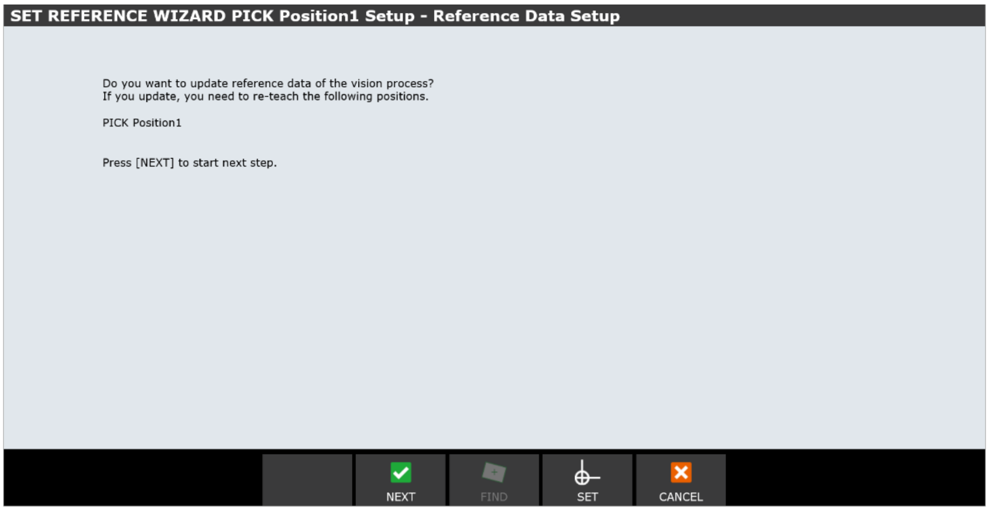


3 The vision process for SEARCH Vision Process is executed, and the message ‘The vision process has run. Please check FIND result in Vision Runtime Page.’ shown below is displayed. On the Vision

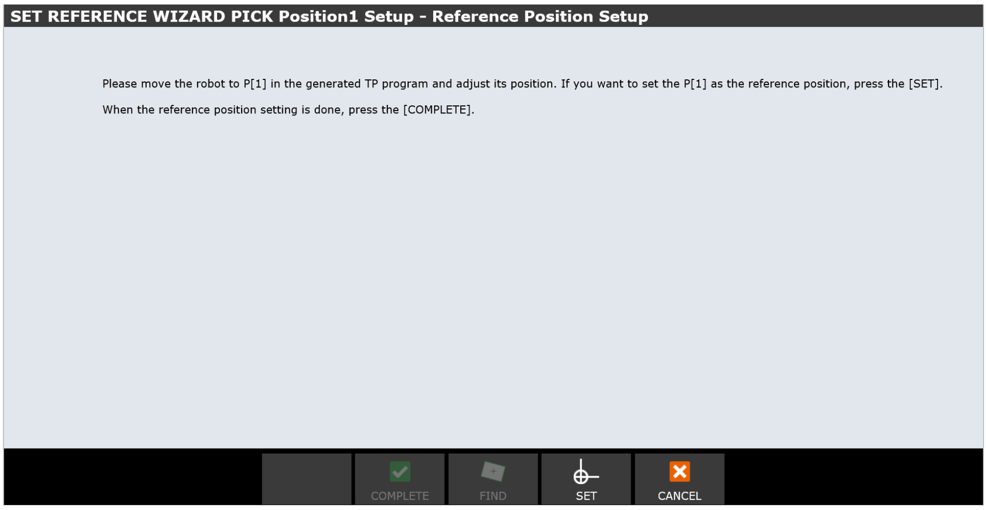
Runtime screen, check that the result of the vision process for SEARCH Vision Process is correct, and click [NEXT].



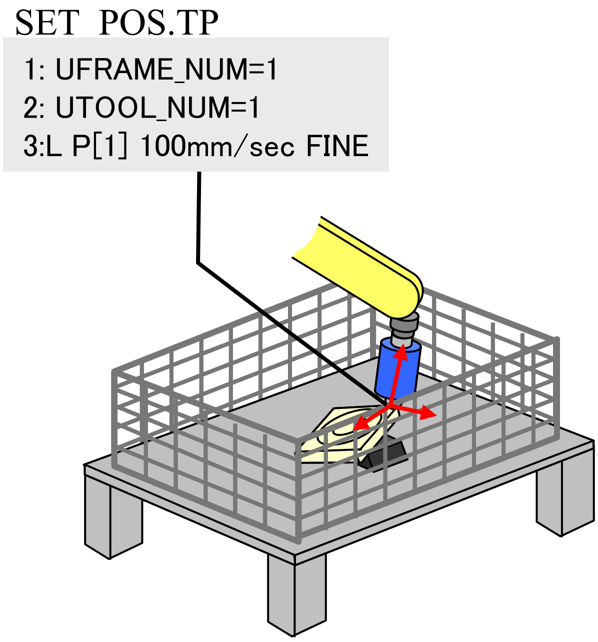
4 The following Reference Data Setup screen appears. Click [SET] to set the reference data of the SEARCH Vision Process, and click [NEXT].



5 The following Reference Position Setup screen appears.
Then, a TP program named SET_POS.TP is automatically generated.

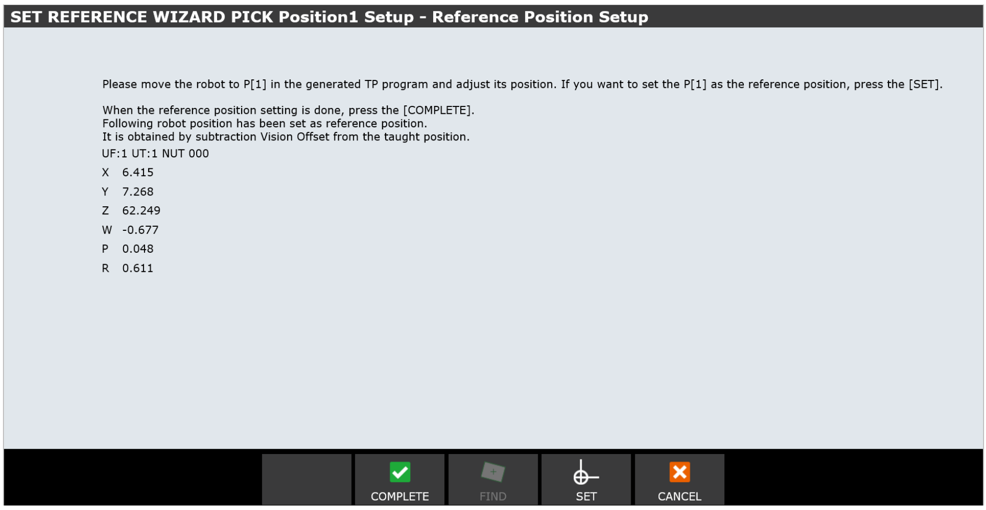


6 Execute the TP program and move to P[1].
The found position of the SEARCH Vision Process is automatically set to P[1]. Move the robot to P[1] and check that the found position is on a point of a part.



Position found by TP program

7 Check whether P[1] is appropriate as a position to pick a part (the position is adjusted if necessary by fine-tuning the position of the robot), and click [SET] in the Reference Position Setup screen, and the set reference PICK position is displayed as follows.



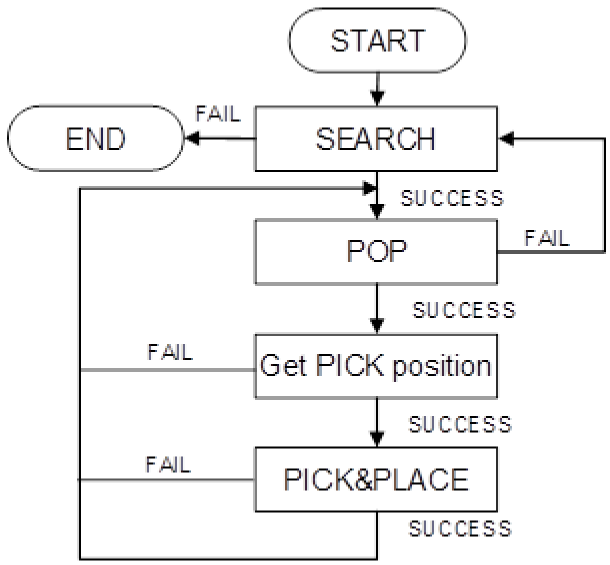
8 Check that the displayed reference PICK position is correct, and click [COMPLETE] to close Set Reference Wizard.

4.8 EDITING TP PROGRAM

Edit the TP program for the Bin Picking system with 3DV Sensor.
This system has a pre-installed sample program. This section explains how to create a program for actually performing bin picking using a 3DV Sensor based on this sample program.

4.8.1 Flow Chart of TP Program

The flow chart of TP program is as follows.



4.8.2 Register Setting Table

TP programs use the following registers, position registers and tool frame and user frame.

Registers to be used

R [10]	The status of the SEARCH Vision process. Each value represents the status described below. 0: SUCCESS (Some new part data are added to a parts list) 1: FAIL (No part data is added to a parts list)
R [11]	The status of POP. Each value represents the status described below. 0: SUCCESS 1: FAIL (No part data that can be popped)
R [12]	The Model ID of the popped part data.
R [13]	The status of the process to get a PICK position. Each value represents the status described below. 0: SUCCESS 12: Failed to get an interference avoidance position at the PICK position 13: Failed to get an interference avoidance position at approach position

Position registers to be used

PR [20]	Result of interference avoidance for the part pick position (avoidance position)
PR [21]	Result of interference avoidance for the part pick position (tool offset value)
PR [22]	Result of interference avoidance for the approach position (avoidance position)
PR [23]	The tool offset value from the PICK Position used for approach position calculation.

Tool frame to be used

UTOOL [1]	The gripper TCP

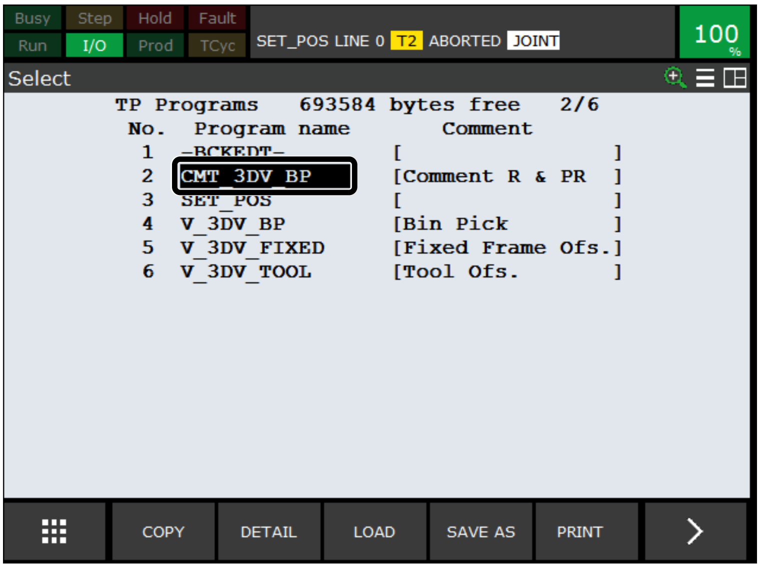
User frame to be used

UFRAME [1]	Application frame

4.8.3 Batch Input of Register Comments

This system comes with a pre-installed sample program. By entering comments to registers and other elements used in this sample program in advance, you can check operation and modify your program easily. Although manually setting comments takes time, it will save the labor of performing the operation.

1 Select and execute [CMT_3DV_BP] on the program list screen.



2 On the register list screen and the position register list screen, check that the comments are entered as follows.

Registers

R [10]	Detection status
R [11]	Pop status
R [12]	Pop model ID
R [13]	Pick status

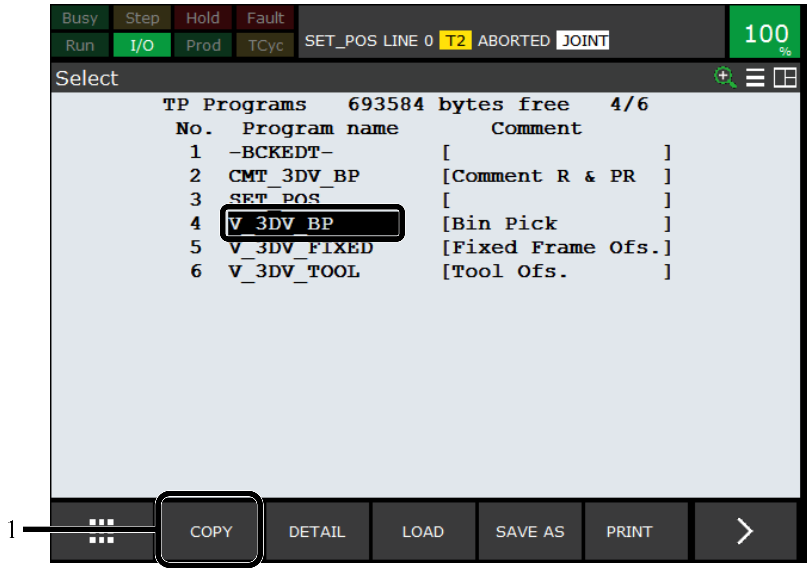
Position registers

PR [20]	Picking
PR [21]	Pick interference offset
PR [22]	Pick approach
PR [23]	Pick approach offset

4.8.4 Editing TP Program

Copy and edit the sample TP program.

1 Select [V_3DV_BP] and click [COPY] on the program list screen.



2 Edit the program name and click [OK].
3 Teach each position in the TP program.

Positions

P[1: Search]	The robot's waiting position when SEARCH is being executed. Teach a position where the robot will not come into the 3DV Sensor's field of view.
P[2: Pick Approach]	The approach position when picking the part. It is desirable that a point directly above the center of the container be taught.
P[3: Place Approach]	The approach position when placing the part.
P[4: Place]	The part placing position.
P[5: Home]	The robot's waiting position. It may be the same position as P[1].

4 Add part picking and placing instructions.
For the CALL instruction in P[5], specify the instruction to pick up the part with the gripper. In this procedure, a macro call to turn ON the vacuum with the vacuum gripper is used as an example. Change it according to the environment you use.

For the CALL instruction in P[6: Place], specify the instruction to release the part from the gripper. In this procedure, a macro call to turn OFF the vacuum with the vacuum gripper is used as an example. Change it according to the environment you use.

V_3DV_BP.TP

This is the sample program for the Bin Picking system. For how to use macro programs such as BINPICK_CLEAR, refer to the Parts List Manager Reference in “*i*RVision Bin Picking Application OPERATOR’S MANUAL B-83914EN-6.”

```
!The register numbers and
!position register numbers below
!should be changed according to
!those set by CMT_3DV_BP.TP.

UFRAME_NUM=1
UTOOL_NUM=1
CALL BINPICK_CLEAR(1)

!SEARCH
LBL[1]
L P[1:Search] 2000mm/sec FINE
CALL BINPICK_SEARCH(1,1,10)
IF R[10:Search Status]<>0,JMP LBL[999]

!POP
LBL[2]
CALL BINPICK_POP(1,11,12) ;
IF R[11:Pop Status]<>0,JMP LBL[1]

!GETPICKPOS
CALL BINPICK_GETPICKPOS(1,1,13,20,21,22)
IF R[13:Pick Status]=0,JMP LBL[3]

CALL BINPICK_SETSTAT(1,22)
JMP LBL[2]

!PICK
LBL[3]
L P[2:Pick Approach] 2000mm/sec CNT100
L PR[22:Pick App.] 2000mm/sec CNT50
L PR[20:Pick] 500mm/sec FINE
!Insert program instructions
!to grasp the part.
CALL ...
CALL BINPICK_SETSTAT(1,20)
L PR[22:Pick App.] 500mm/sec CNT50
L P[2:Pick Approach] 2000mm/sec CNT100

!PLACE
L P[3:Place Approach] 2000mm/sec CNT100
L P[4:Place] 500mm/sec FINE
!Insert program instructions
!to release the part.
CALL ...
L P[3:Place Approach] 2000mm/sec CNT100

!CONTINUOUS
JMP LBL[2]

!END
LBL[999]
J P[5:Home] 100% FINE
```

- UFRAME_NUM=1: Specify the user frame number set in “4.2 SETTING USER FRAME”.
- UTOOL_NUM=1: Specify the tool frame number set in “4.4 SETTING TOOL FRAME”.
- CALL BINPICK_SEARCH(1,1,10): Execute SEARCH Vision Process.
- IF R[10:Search Status]<>0,JMP LBL[999]: If any part cannot be found, terminate the process.
- IF R[11:Pop Status]<>0,JMP LBL[1]: If part data fails to be popped, execute the SEARCH vision process.
- JMP LBL[2] (after BINPICK_SETSTAT(1,22)): If the PICK position fails to be acquired, pop the next part data.
- L PR[20:Pick] 500mm/sec FINE: Move to the part pick position
- L P[4:Place] 500mm/sec FINE: Move to the part placement position
- JMP LBL[2] (!CONTINUOUS): After placing a part, pop the next part data.

4.9 CHECKING ROBOT OFFSET OPERATION

Check that a part in the container can be detected and picked up accurately.
Start with lower override of the robot to check that the logic of the program and the motion of the robot are correct. Next, increase the override and keep the robot running continuously to check that it works properly.

- Place the part near the reference position, find it and check that it can be picked up accurately. If the accuracy of compensation is low, retry the reference position setting.
- Move the part in the X direction or Y direction without rotation, find it and check that it can be picked up accurately.
- Rotate the part, find it and check that it can be picked up accurately.
- Change the part’s height, find it and check that it can be picked up accurately.
- Tilt the part, find it and check that it can be picked up accurately.

Know-How

1 FRAME SETTING

This chapter explains the setting method for the user frame and tool frame.
In *i*RVision, the following frames are used.

- World frame
  The frame that is defined in the robot from the start. A specified location is defined for each model of robot. It cannot be changed.
- User frame
  A frame that is defined by a user. It is expressed using a relative position from the world frame. It will be the same as the world frame when it is not set.
- Tool frame
  A frame that shows the tool center point (TCP) and orientation of a tool. It needs to be set up in accordance with each tool.

In *i*RVision, the above frames need to be setup in [Application Frame] or [Offset Frame].
For details on the general method for frame setting, refer to the description of setting coordinate systems in "OPERATOR'S MANUAL (Basic Function) B-83284EN."
There are two methods for frame setting. Refer to the following for each setting method.

- Setting with a pointer tool
  For the setting method, refer to "Know-How: 1.1 FRAME SETTING WITH POINTER TOOL."
- Setting with the calibration grid frame setting function
  For the setting method, refer to "Know-How: 1.2 FRAME SETTING WITH GRID FRAME SETTING FUNCTION."

1.1 FRAME SETTING WITH POINTER TOOL

This is a method for setting a user frame or tool frame by physically performing touch-up with a pointer tool.
This section explains a user frame and tool frame with the following configuration.

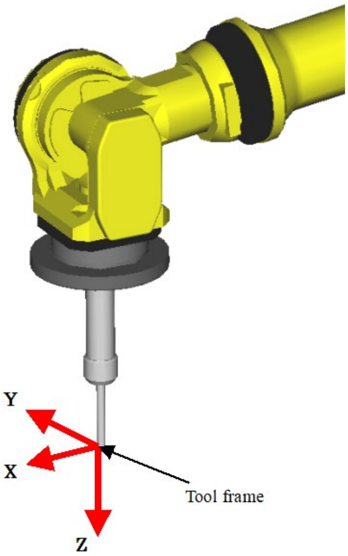
- For details of the user frame setting, refer to "Know-How: 1.1.1 User Frame Setting."
- For details of the tool frame setting, refer to "Know-How: 1.1.2 Tool Frame Setting."

1.1.1 User Frame Setting

This subsection explains a method for user frame setting on an arbitrary plane with a pointer attached on the robot end of the arm tooling. It is necessary to perform a TCP setup to a pointer tool as preparation.

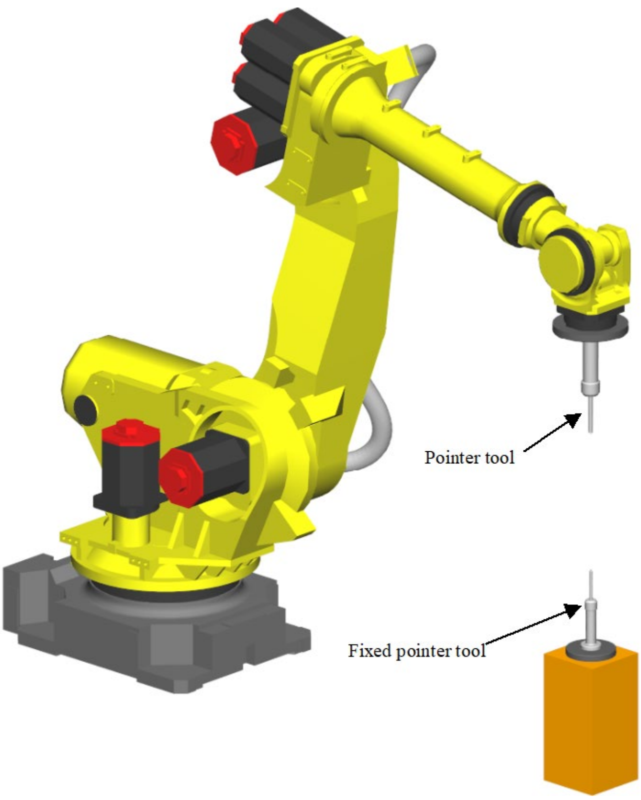
1.1.1.1 TCP set up

Attach a pointer tool on the robot end of the arm tooling, and set TCP to an arbitrary tool frame number.



Pointer tool and tool frame

Prepare a pointer tool with a sharp tip. Make sure that the pointer tool is fixed securely to the robot end of arm tooling so that it remains in place while the robot moves. It is recommended that positioning pins or other appropriate means may be used so that the pointer tool can be mounted at the same position. Moreover, prepare another pointer with a sharp tip, and fixed on the table. The position of the fixed pointer can be set as desired. TCP is set up by touch-up the tip of the fixed pointer with the tip of the pointer attached on the robot end of the arm tooling. Use the "Three point method" for setting a TCP. If the accuracy of this TCP setting is low, the precision in handling of a workpiece by the robot is also degraded.

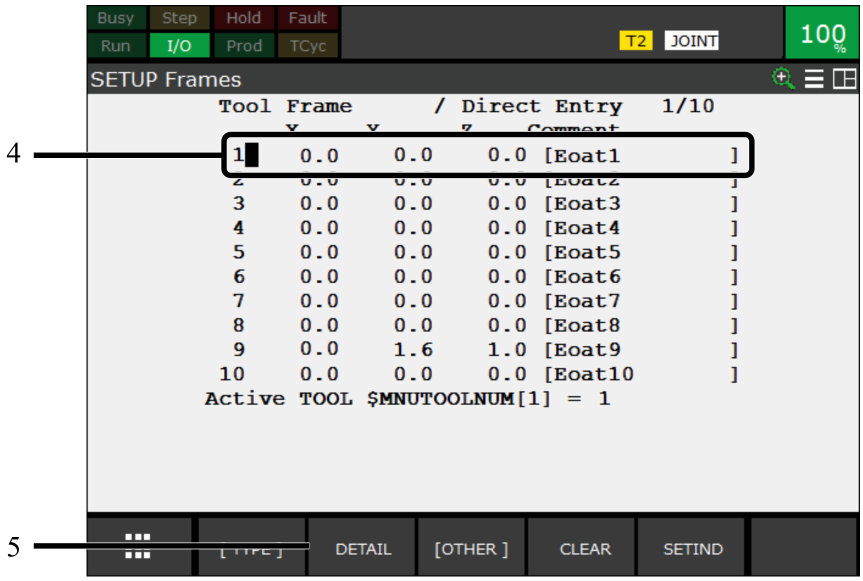


Example of a layout for pointer tool and fixed pointer tool

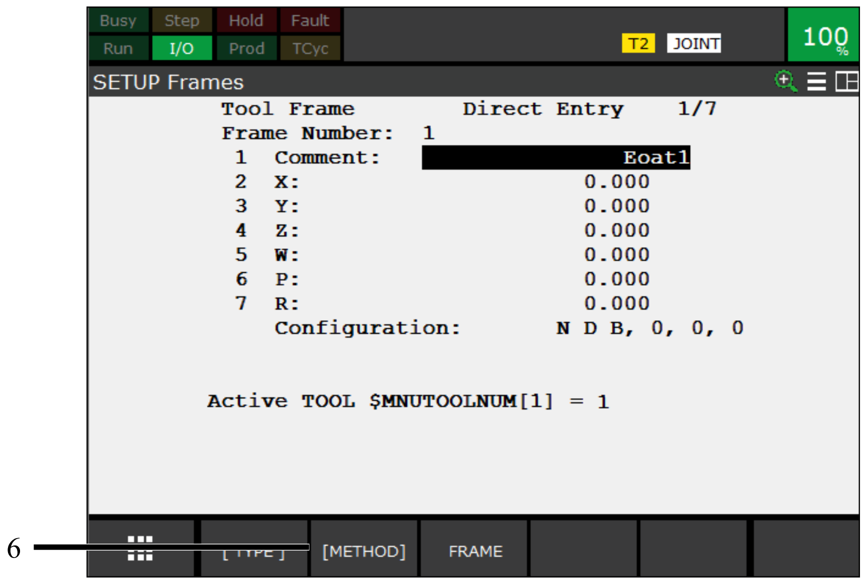
Three point method

Use the three point method to define the tool center point (TCP). The three approach points must be taught with the tool touching a common point from three different approach statuses. As a result, the location of TCP is automatically calculated. To set the TCP accurately, three approach directions had better differ from others as much as possible. In the three point method, only the tool center point (x, y, z,) can be set. The setting value of tool orientation (w, p, r) is the standard value (0, 0, 0). It is not necessary that change the (w, p, r) value.

1 On the teach pendant, after selecting the [MENU] key → [SETUP], place the cursor over [Frames] and press the [ENTER] key.
2 Press F3 [OTHER].
3 Place the cursor over [Tool Frame] and press the [ENTER] key.
The list screen for tool frames will appear.

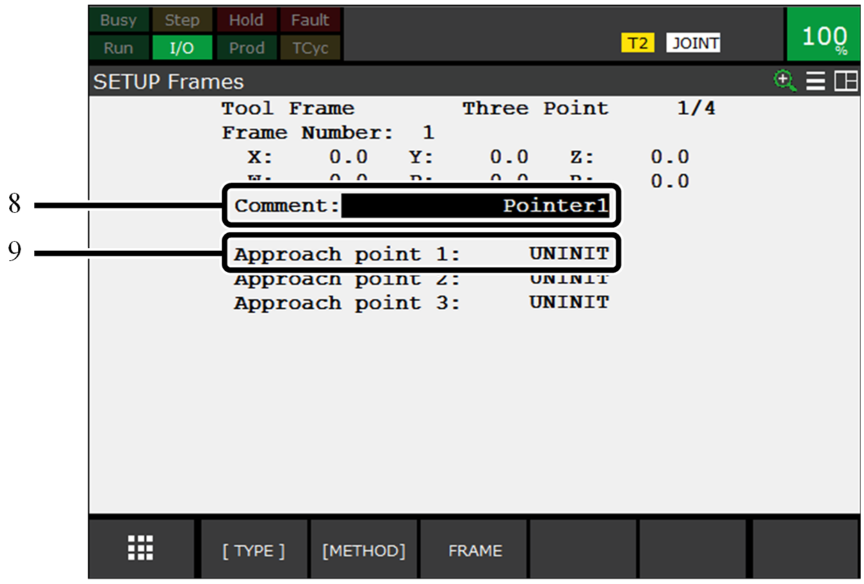


4 Place the cursor over the line of the tool frame number to be set.
5 Press F2 [DETAIL].
The setup screen for the tool frame for the selected frame number will appear.

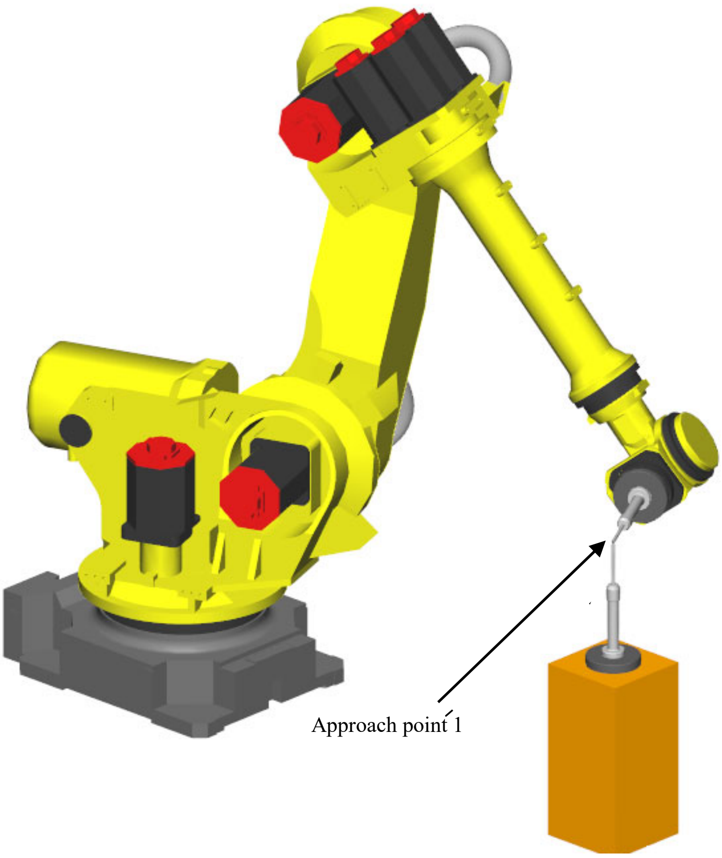


6 Press F2 [METHOD].

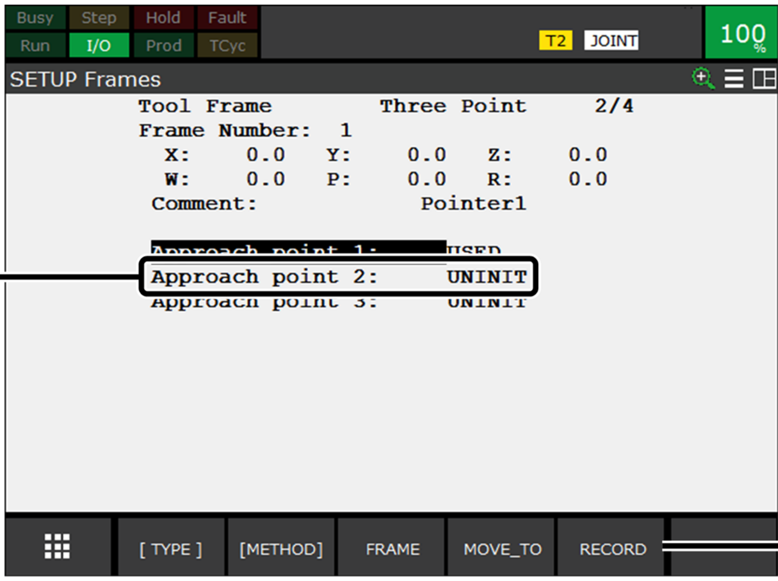
7 Place the cursor over [Three Point] and press the [ENTER] key.
A screen for tool frame setting using the three point teaching method will appear.



8 Enter a comment in the [Comment] field as necessary.
A comment to distinguish this frame from other frames is recommended.
9 Place the cursor over [Approach point 1].
10 Jog the robot and touch up the fixed pointer tool pin with the robot pointer tool pin.



Touch-up of approach point 1

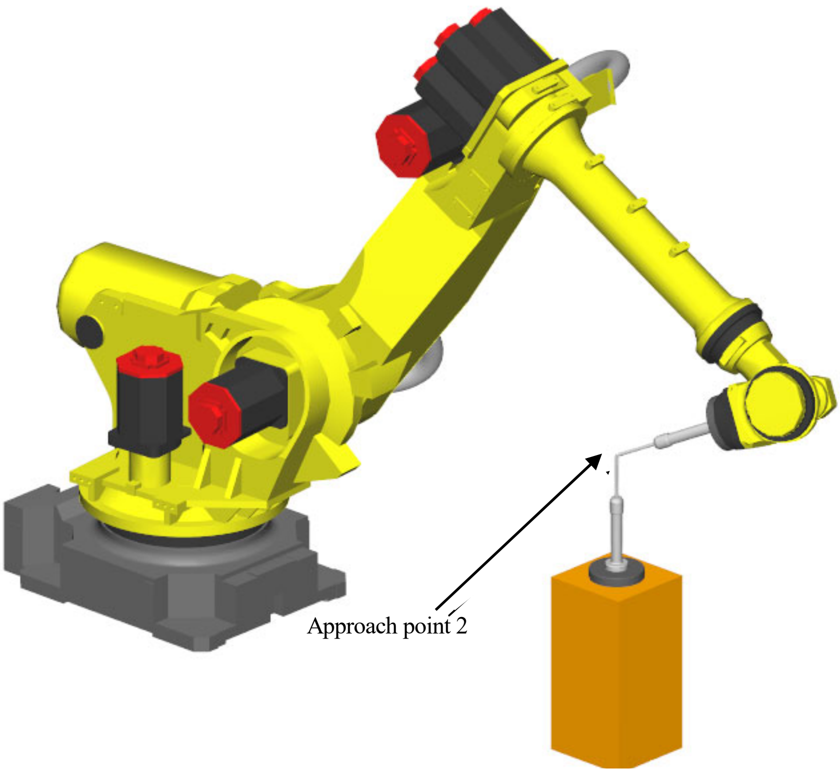
12


11

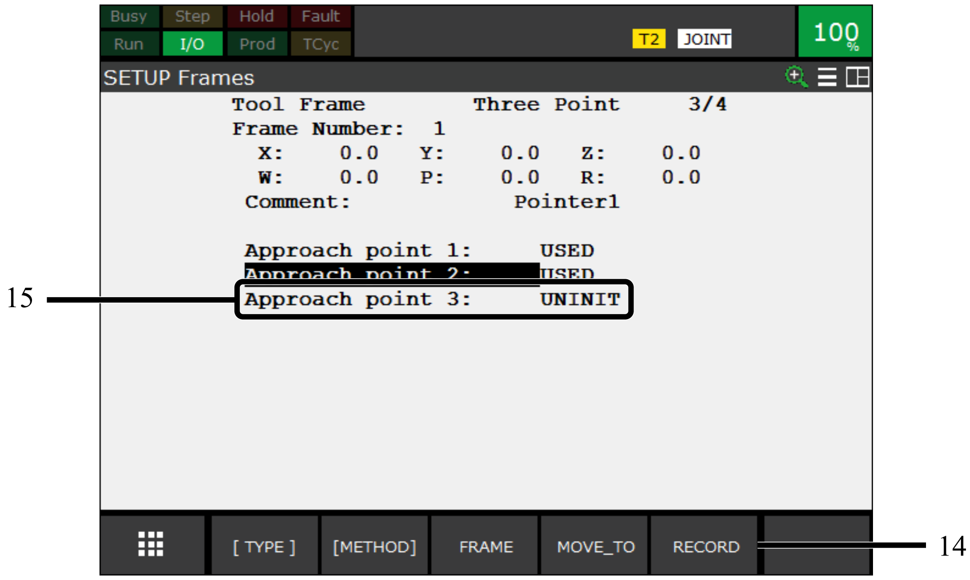
11 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 1.
[Used] will appear for [Approach point 1].

12 Place the cursor over [Approach point 2].

13 Jog the robot and touch up the fixed pointer tool pin with the robot pointer tool pin.
Touch up the same point as approach point 1. However, change the robot orientation from that of approach point 1.



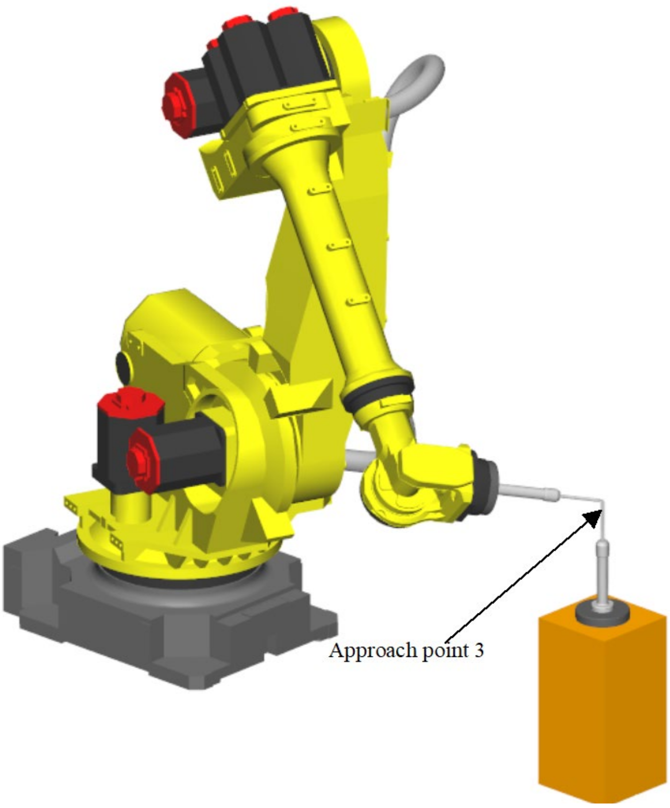
Touch-up of approach point 2



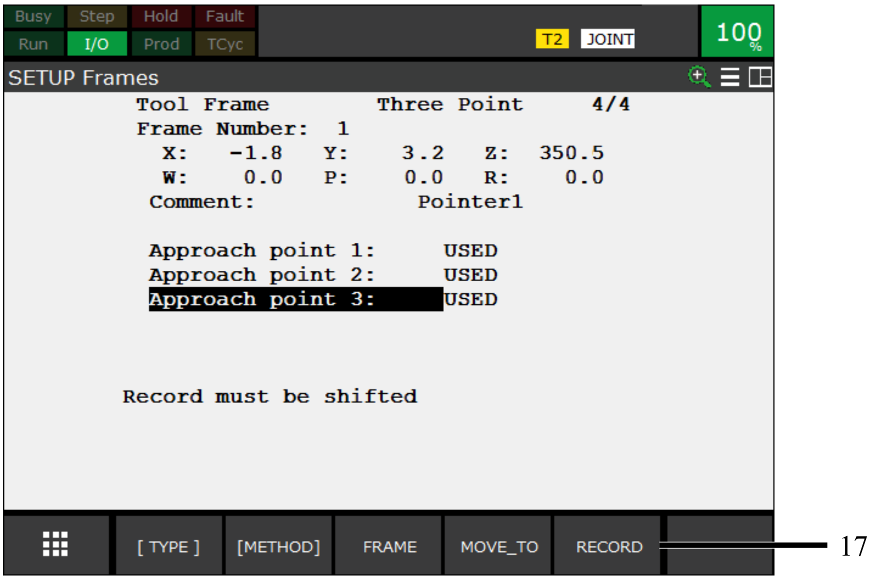
14 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 2.
For the taught [Approach point 2], [Used] will appear.

15 Move the cursor to [Approach point 3].

16 Jog the robot and touch up the fixed pointer tool pin with the robot pointer tool pin.
The position of approach point 3 is the same as approach point 1 and 2. However, the posture of approach point 3 is different from the posture of approach point 1 and 2.

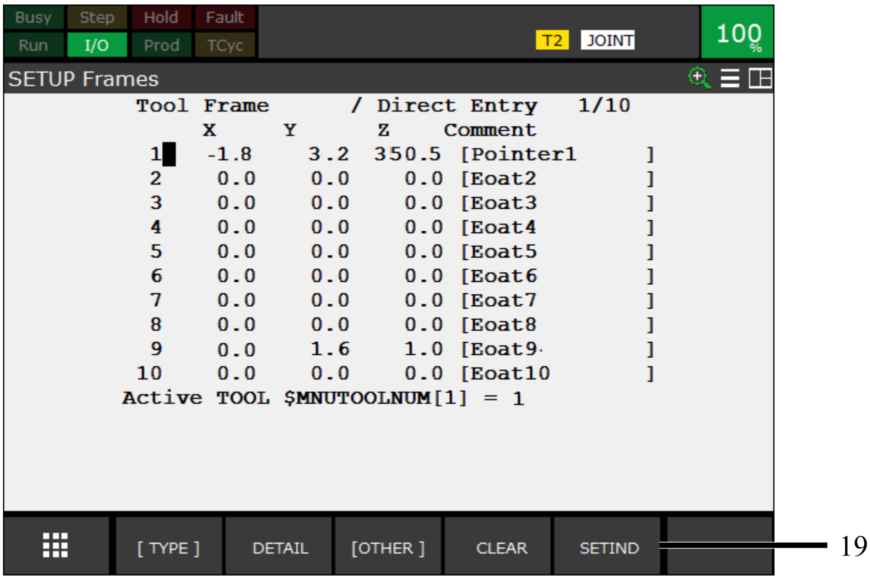


Touch-up of approach point 3



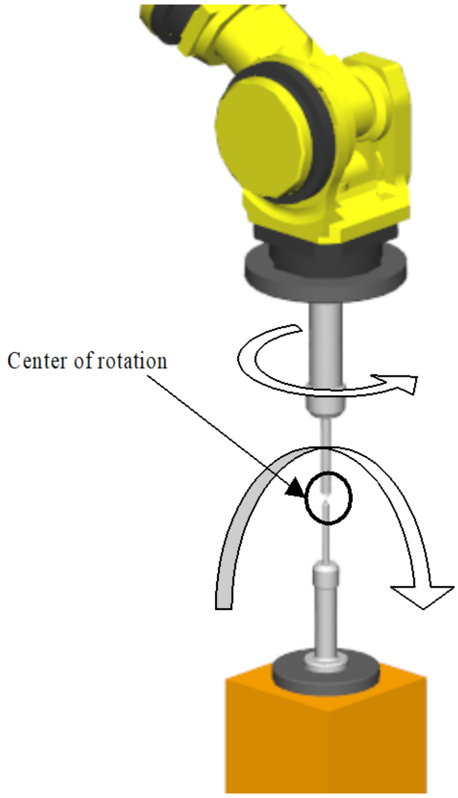
17 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 3.
When all the approach points are taught, [Used] will appear. The tool frame has been set.

18 Press the [PREV] key.
The list screen for tool frames will appear.



19 Check that the TCP is set accurately. Press F5 [SETIND] and enter a frame number.
The tool frame that has been set will be set as the currently enabled tool frame.

20 Jog the robot to move its pointer tool close to the tip of the fixed pointer tool.



Check by moving the pointer tool close to the tip of the fixed pointer tool

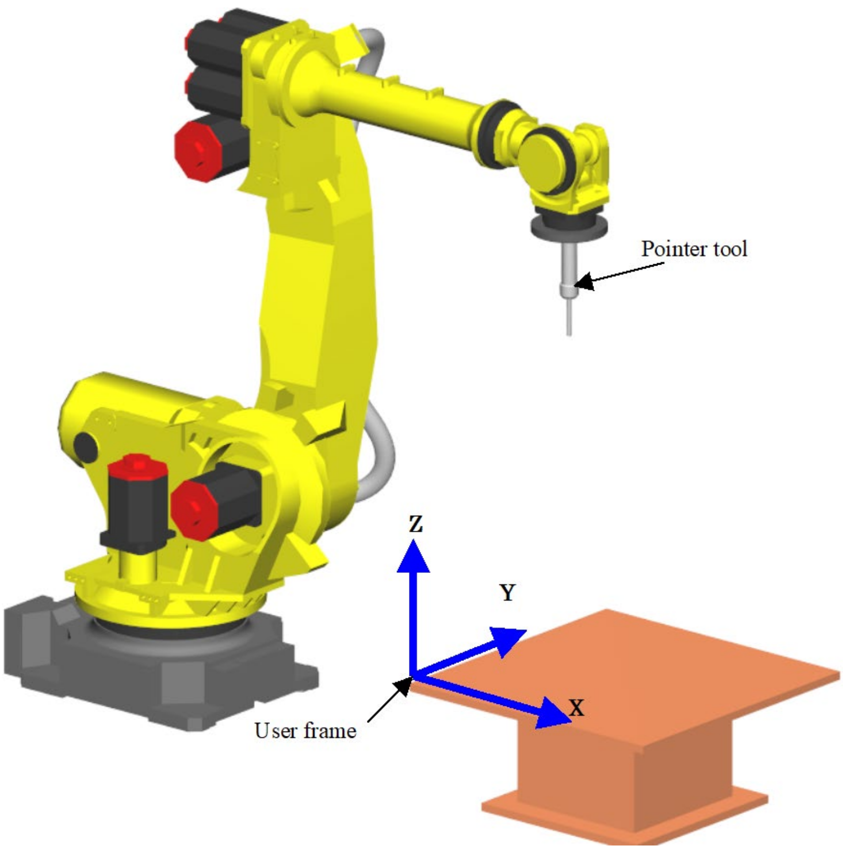
21 Jog the robot around the tool frame, and change the orientation of the tool (w, p, r). If the TCP is accurate, the tip of the pointer tool will always point toward the tip of the fixed pointer tool.

1.1.1.2 Setting method types and procedures

There are three methods of setting a user frame, the "Three point method," "Four point method" and "Direct list method." For settings of the three point method and four point method, use the touch-up pointer set in "Know-How: 1.1.1.1 TCP set up." Moreover, the farther away each taught point is, the better the accuracy of the user frame setting becomes. When setting the calibration grid frame, the "Four point method" allows the distance of each taught point to be farther away than the "Three point method." When setting the calibration grid frame, the "Four point method" is recommended. The "Three point method" and "Four point method" are explained as shown below.

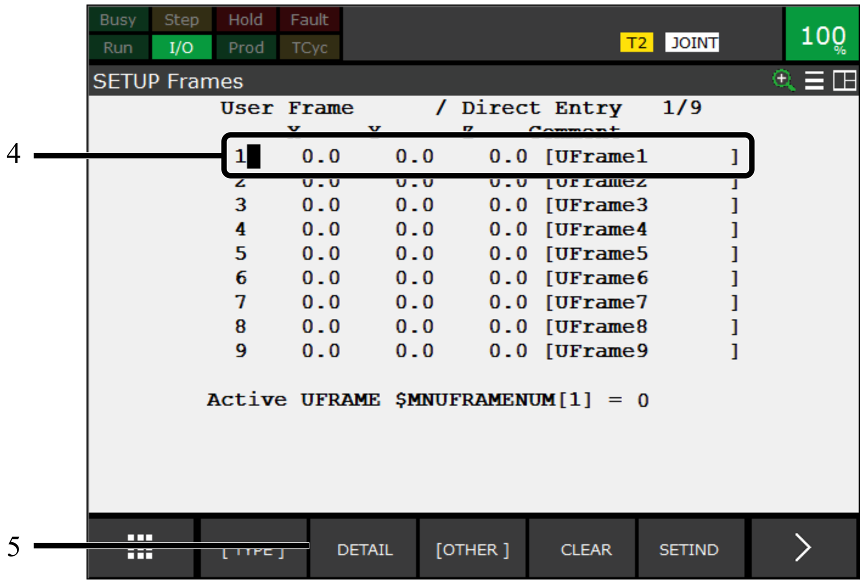
Three point method

Teach the following three points: the origin of the x-axis, the point that specifies the positive direction of the x-axis, and the point on the x-y plane. In the example of the following figure, the user frame is set on the table so that the XY plane of the user frame is parallel with the table plan.

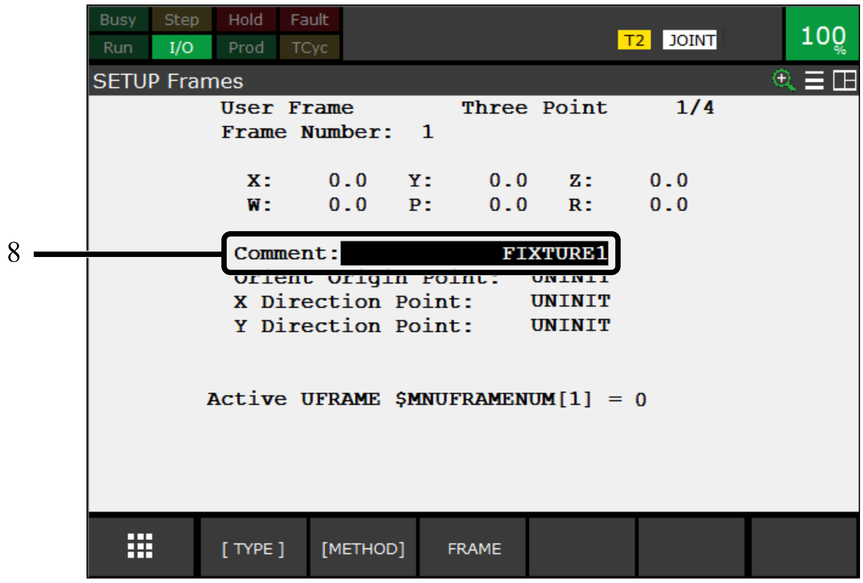


Example for setting a user frame that is parallel with a work table plane

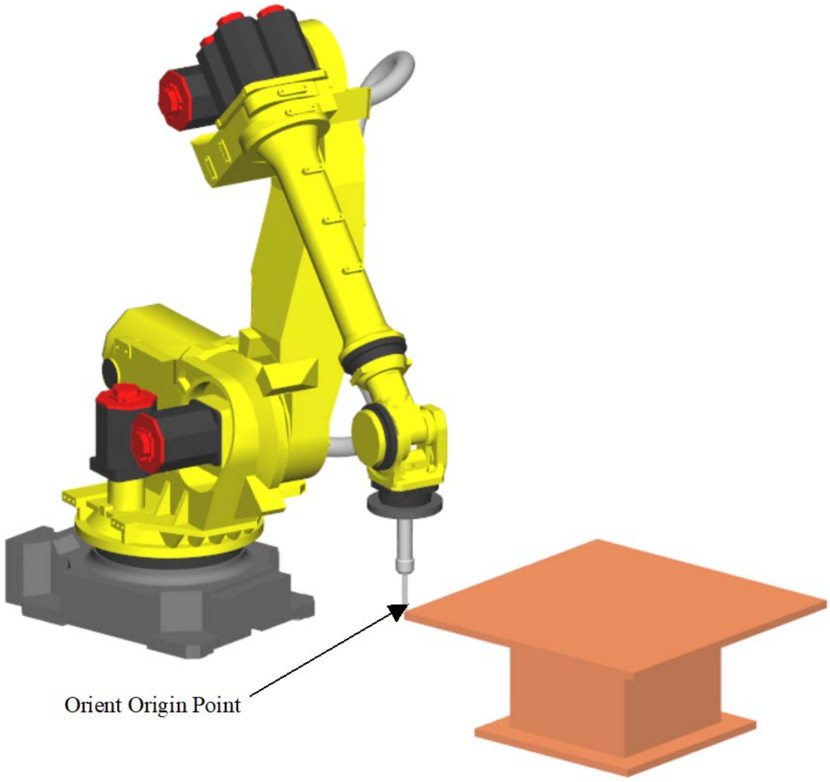
1 On the teach pendant, after selecting the [MENU] key → [SETUP], place the cursor over [Frames] and press the [ENTER] key.
2 Press F3 [OTHER].
3 Place the cursor over [User Frame] and press the [ENTER] key.
The following list screen for user frames will appear.



4 Place the cursor over the line number of the frame to be set.
5 Press F2 [DETAIL].
The SETUP Frames screen for the selected frame will appear.
6 Press F2 [METHOD].
7 Place the cursor over [Three Point] and press the [ENTER] key.
A screen for user frame setting using the three point teaching method will appear.

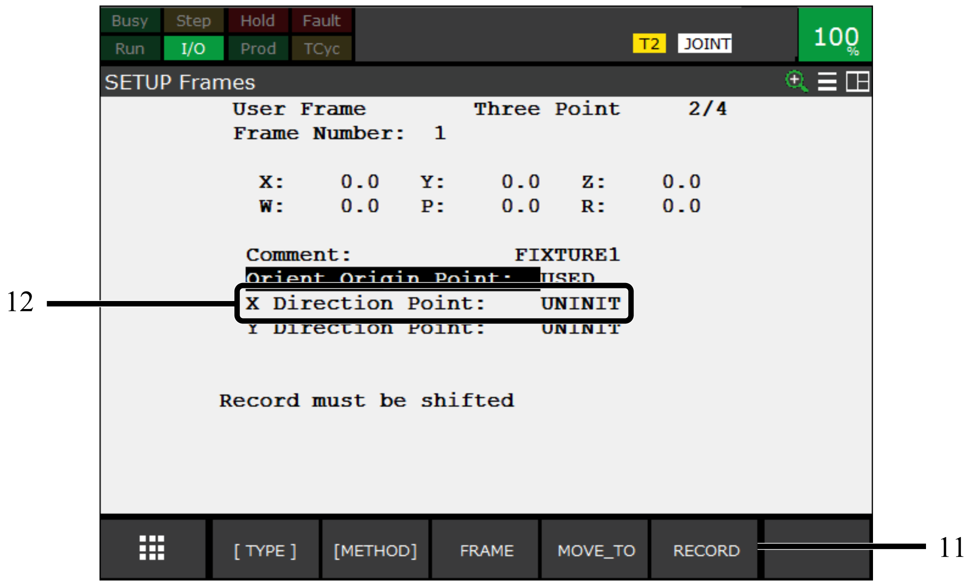


8 Enter a comment in the [Comment] field as necessary.
A comment to distinguish this frame from other frames is recommended.
9 Move the cursor to the [Orient Origin Point].
10 Jog the robot and touch up the origin of the frame with the pointer tool pin.



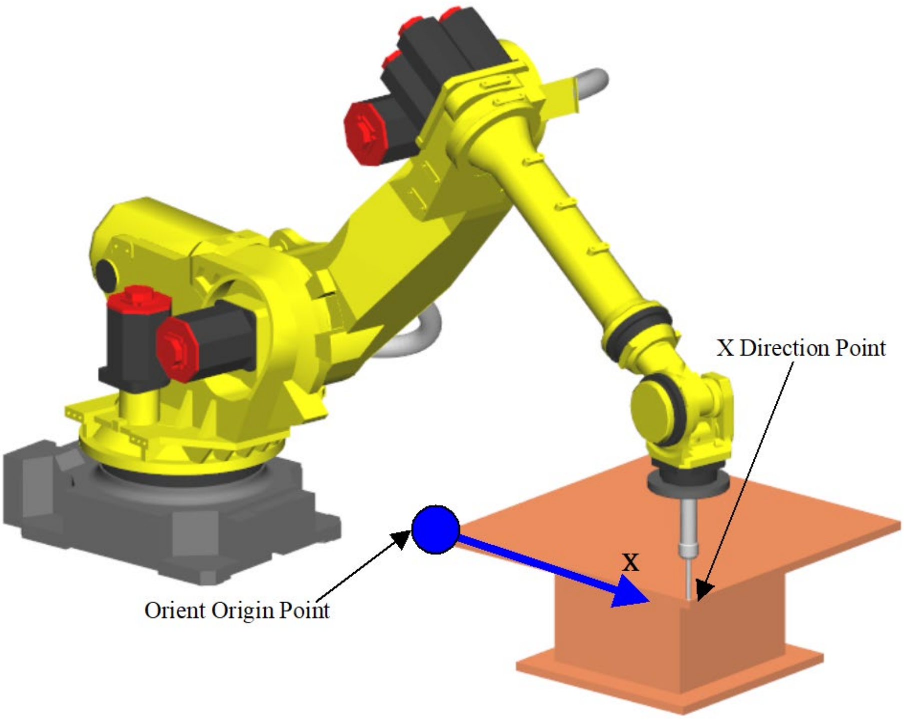
Touch-up of the orient origin point

11 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the orient origin of the frame.
As for the taught [Orient Origin Point], [USED] will appear.

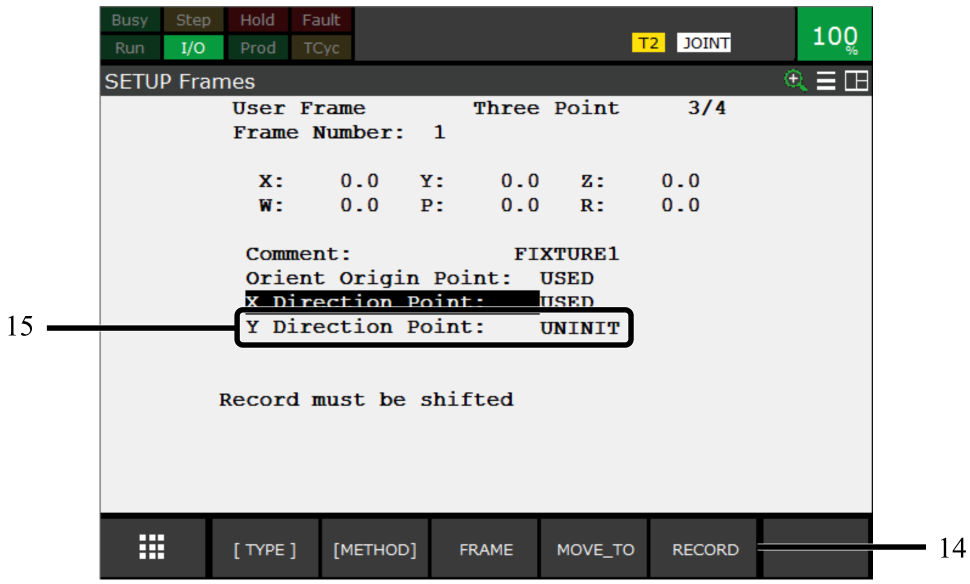


12 Move the cursor to the [X Direction Point].

13 Jog the robot and touch up the X direction point with the pointer tool.
A line drawn between the orient origin point and the touched up X direction point will be the X-axis of the frame.



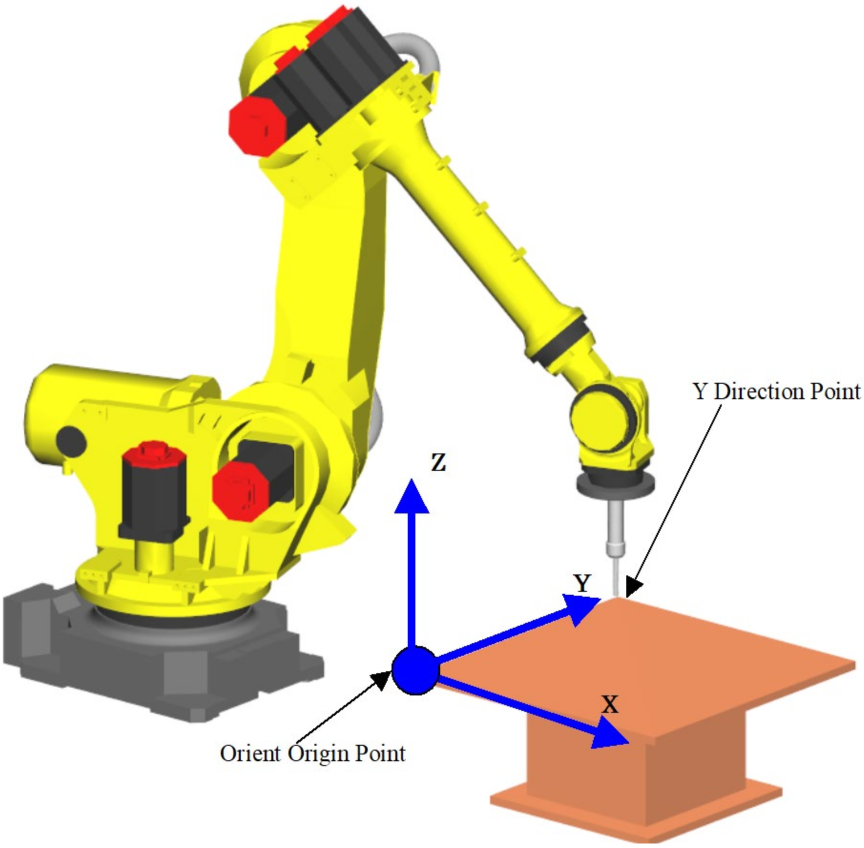
Touch-up of X direction point



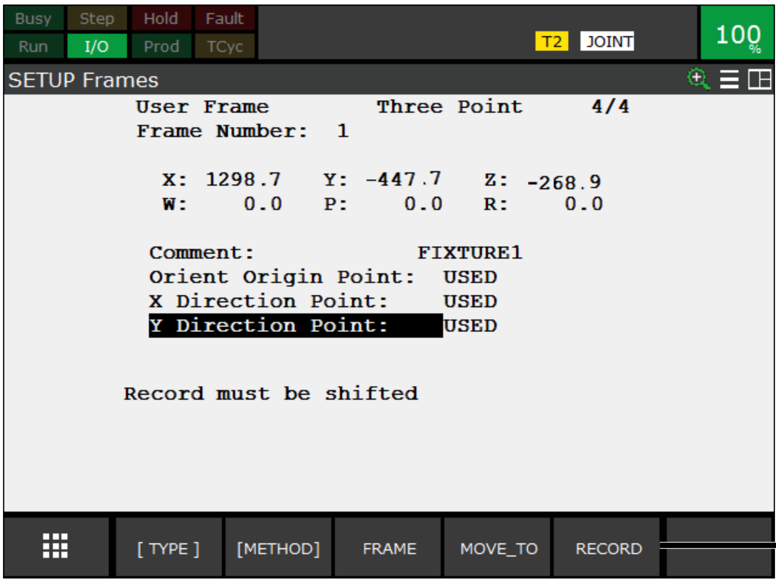
14 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the X direction point.
[USED] will appear for [X Direction Point].

15 Move the cursor to the [Y Direction Point].

16 Jog the robot and touch up the Y direction point with the pointer tool.
Touching up the Y-axis direction will determine the X and Y plane of the frame.

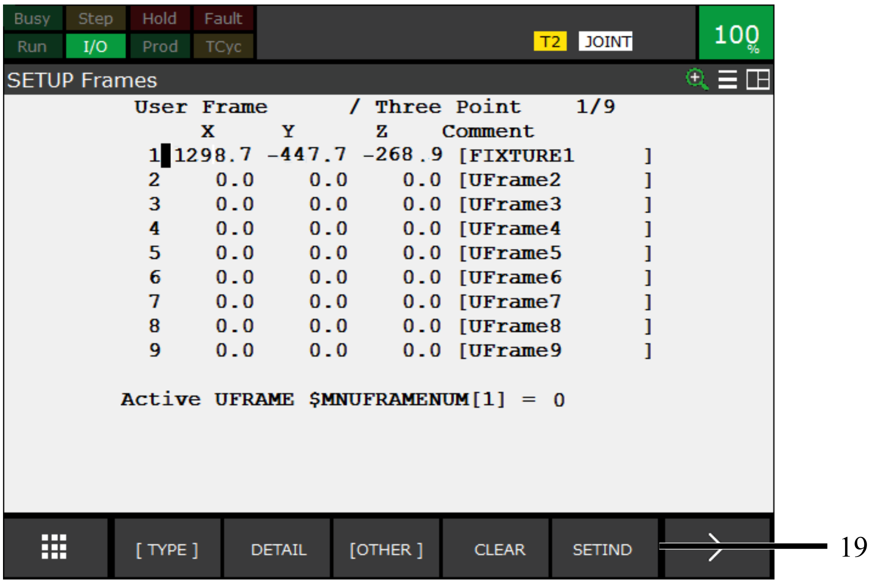


Touch-up of Y direction point



17 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the Y direction point.
When all the approach points are taught, [USED] will appear. The user frame will be set.

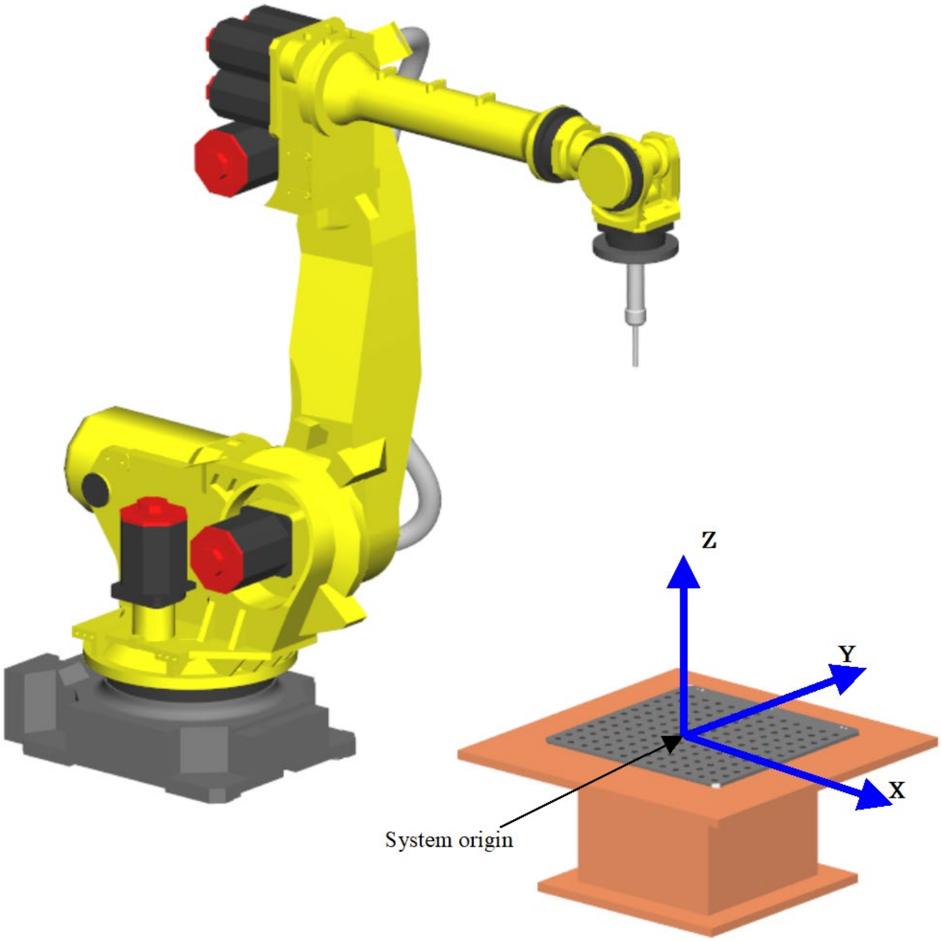
18 Press the [PREV] key.
The User Frame list screen will appear.



19 Press F5 [SETIND] and enter a frame number.
The user frame that has been set will be set as the currently enabled user frame.

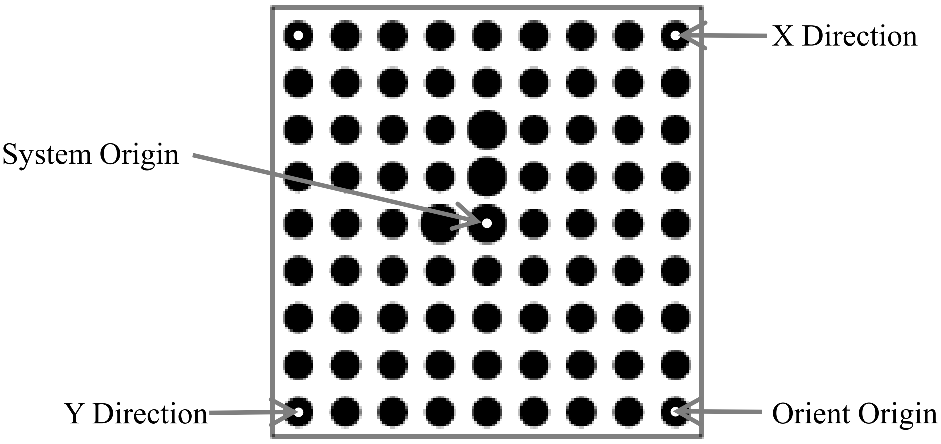
Four point method

Teach the following four points: the origin of the x-axis parallel to the frame, the point that specifies the positive direction of the x-axis, a point on the xy plane, and the origin of the frame. In the example of the following figure, the user frame is set on the fixed calibration grid.



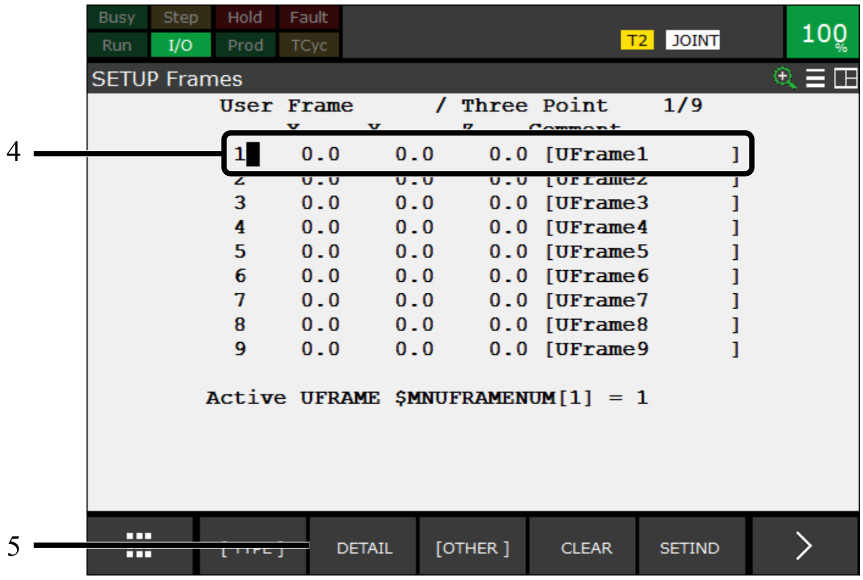
Example of setting a user frame on a fixed calibration grid

The following figure is a calibration grid. When performing the Grid Pattern Calibration for camera calibration, it is necessary to set up a user frame such as shown in the following figure. Since it is necessary to set an Orient origin on the center of a calibration grid, when the "Three point method" is used, the distance from the Orient Origin to the X Direction Point or the Y Direction Point is shorter. The accuracy of user frame setting is better when the "Four point method" is used.

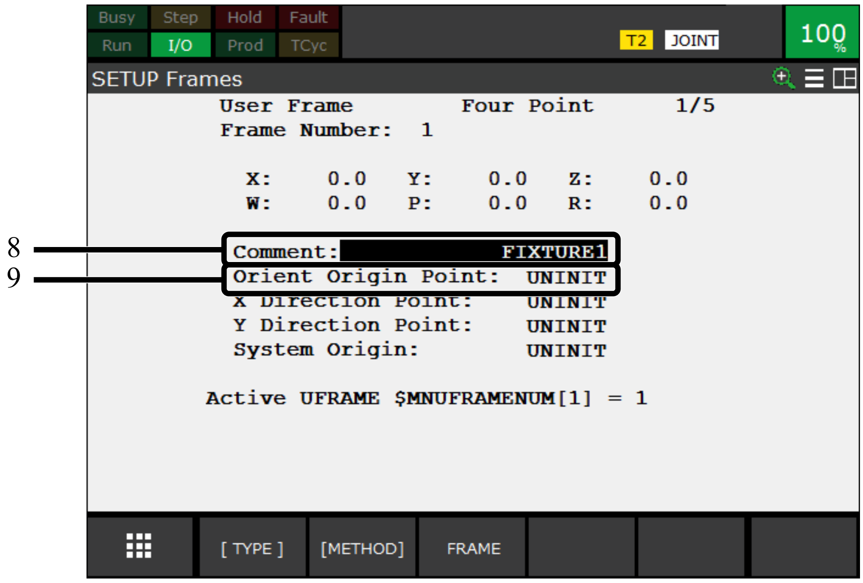


Four point teaching method touch-up points for a calibration grid

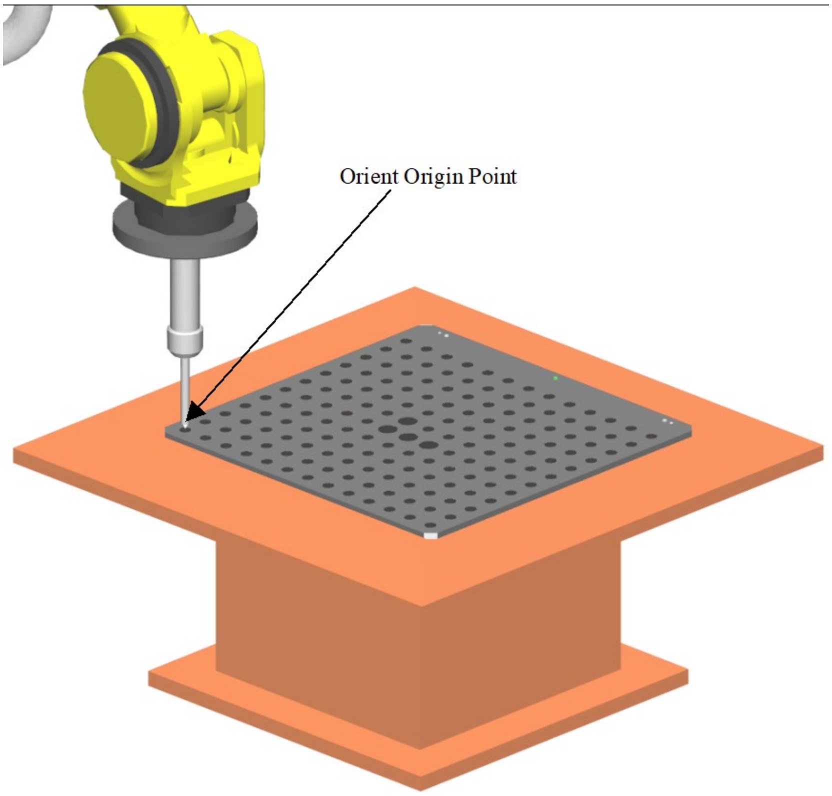
1 On the teach pendant, after selecting the [MENU] key → [SETUP], place the cursor over [Frames] and press the [ENTER] key.
2 Press F3 [OTHER].
3 Place the cursor over [User Frame] and press the [ENTER] key.
The list screen for user frames will appear.



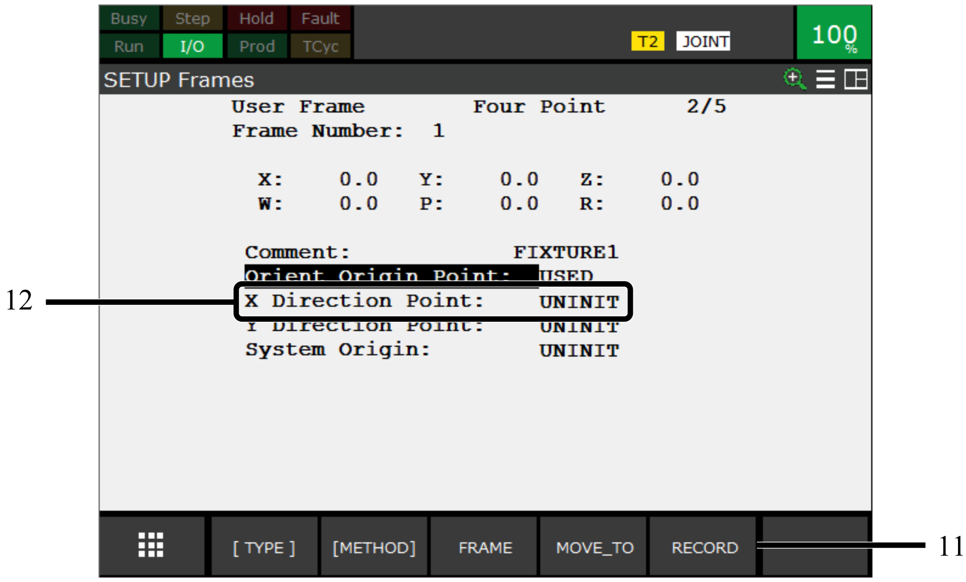
4 Place the cursor over the line number of the frame to be set.
5 Press F2 [DETAIL].
The SETUP Frames screen for the selected frame will appear.
6 Press F2 [METHOD].
7 Place the cursor over [Four Point] and press the [ENTER] key.
A screen for user frame setting using the four point teaching method will appear.



8 Enter a comment in the [Comment] field as necessary.
A comment to distinguish this frame from other frames is recommended.
9 Place the cursor over [Orient Origin Point].
10 Jog the robot and touch up the X direction origin point with the pointer tool.



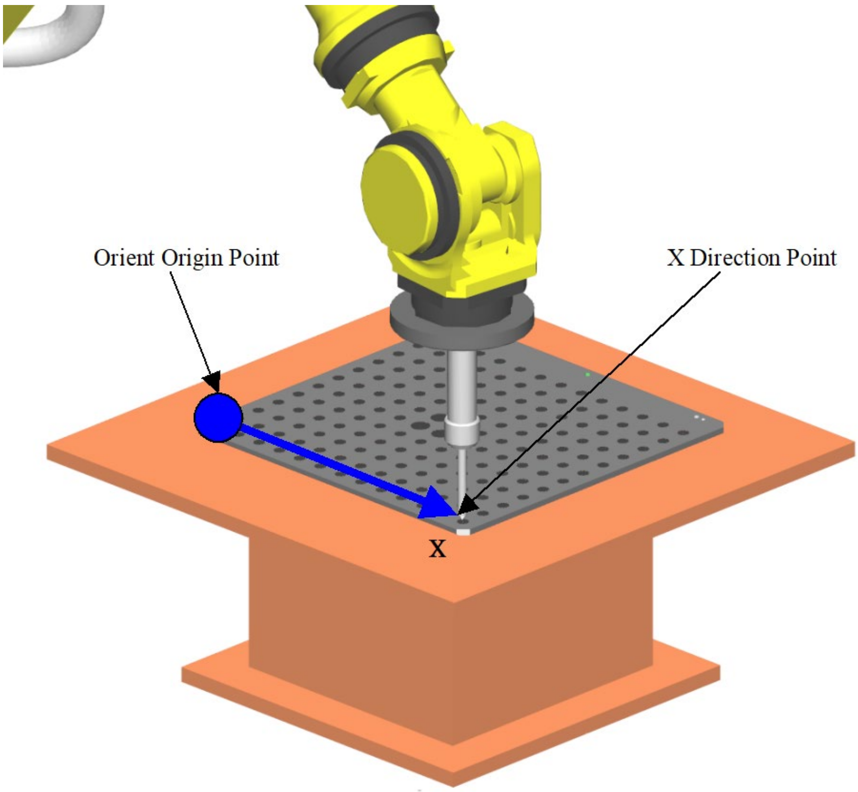
Touching up the orient origin point



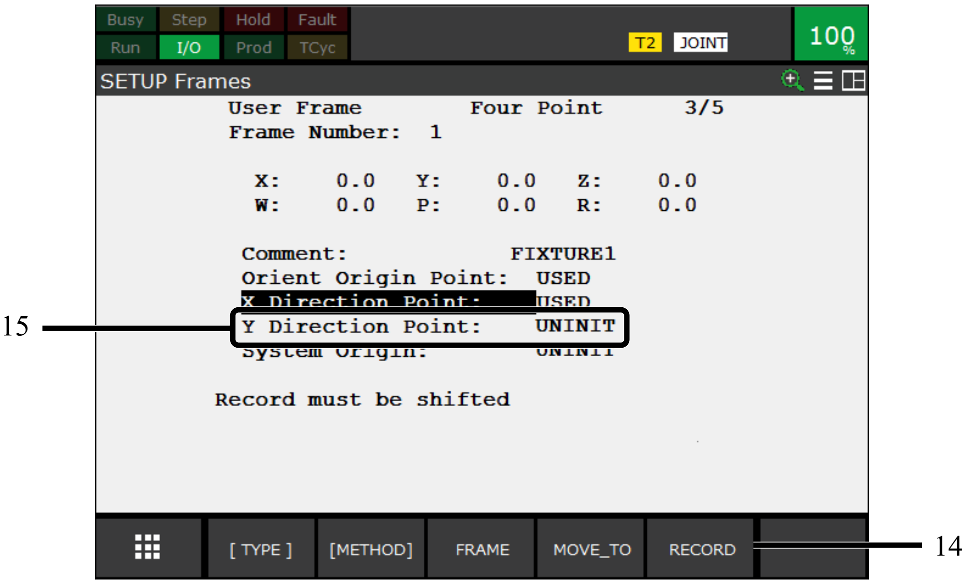
11 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be entered as the X-axis origin point.
For the taught [Orient Origin Point], [Used] will appear.

12 Move the cursor to the [X Direction Point].

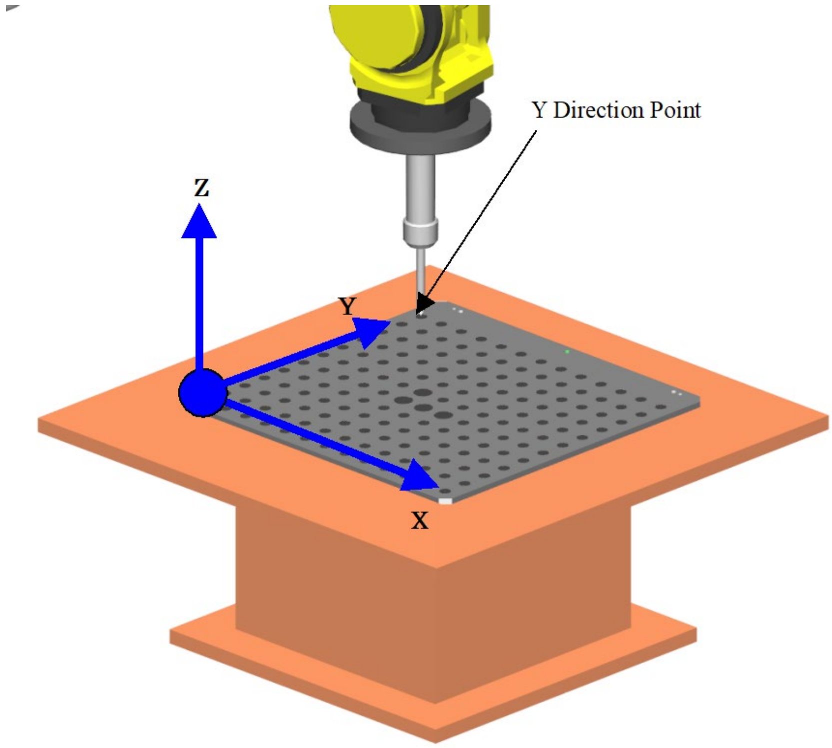
13 Jog the robot and touch up the X direction point with the pointer tool.
A line drawn between the orient origin point and the touched up X direction point will be the X-axis of the frame.



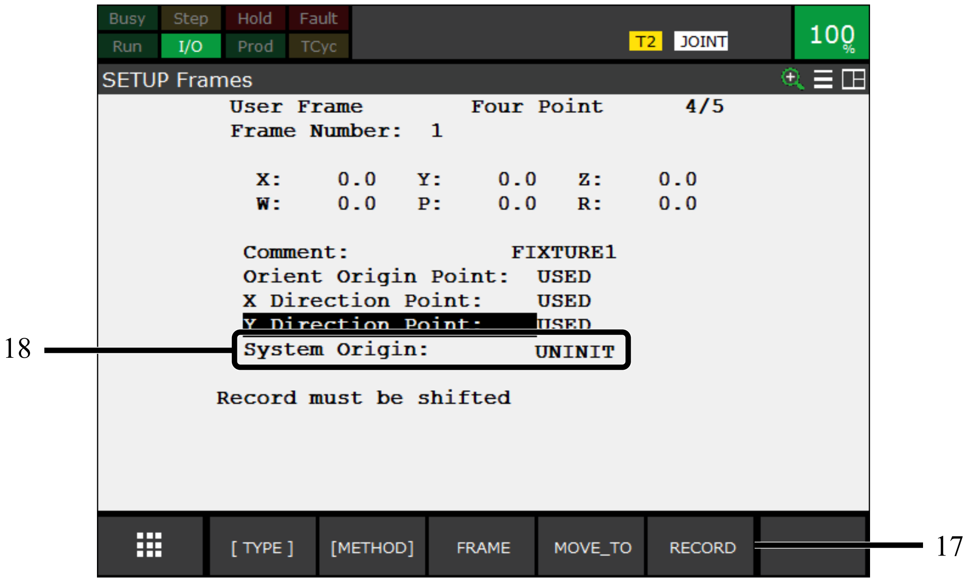
Touch-up of X direction point



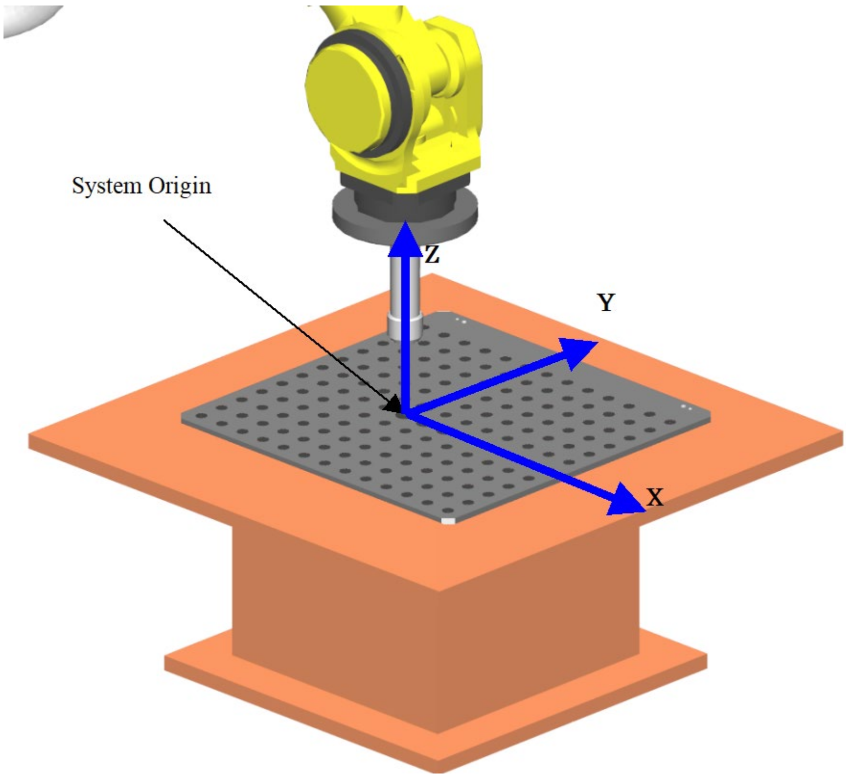
14 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the X direction point.
[USED] will appear for [X Direction Point].
15 Move the cursor to the [Y Direction Point].
16 Jog the robot and touch up the Y direction point with the pointer tool.
Touching up the Y-axis direction will determine the X and Y plane of the frame.



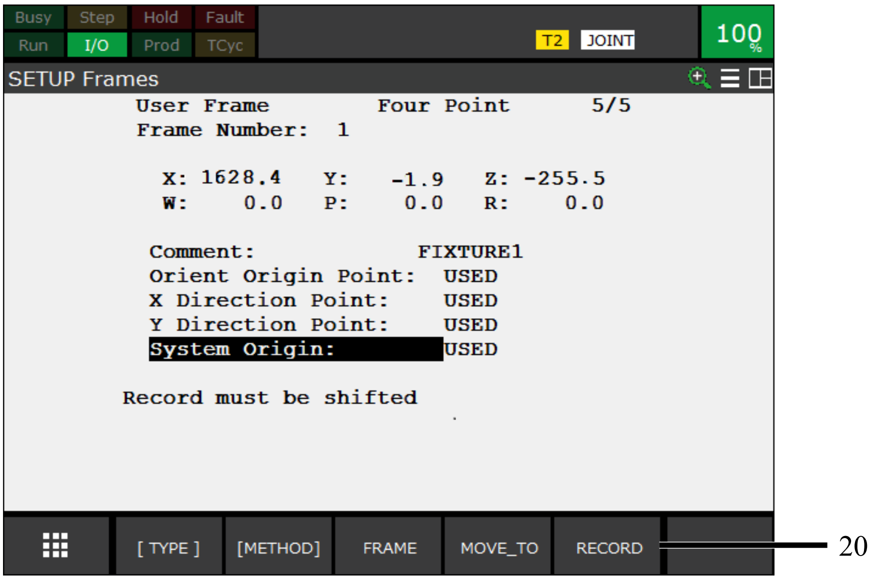
Touch-up of Y direction point



17 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the Y direction point.
[USED] will appear for the taught [Y Direction Point].
18 Move the cursor to the [Orient Origin Point].
19 Jog the robot and touch up the orient origin point of the frame with the pointer tool.



Touch-up of the orient origin point



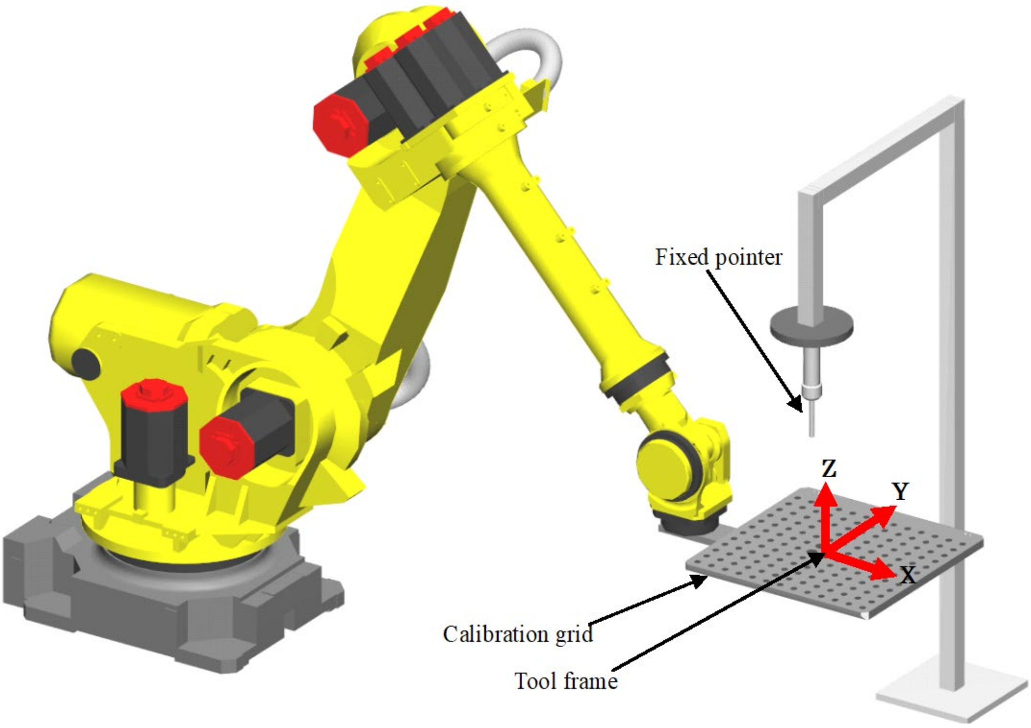
20 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the orient origin of the frame.
When all the approach points are taught, [USED] will appear. The user frame will be set.

21 Press the [PREV] key.
The User Frame list screen will appear.

22 Press F5 [SETIND] and enter a frame number.
The user frame that has been set will be set as the currently enabled user frame.

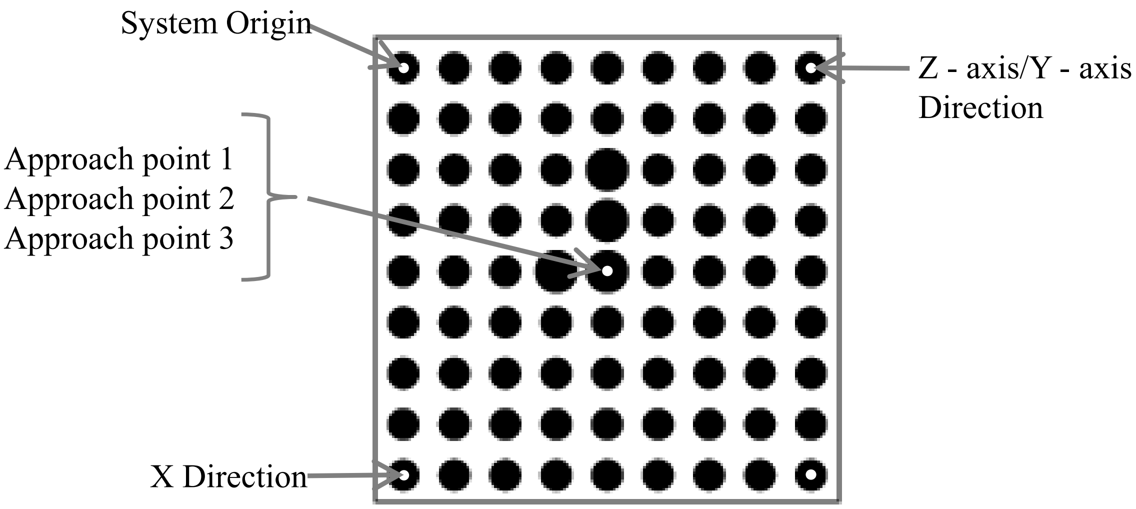
1.1.2 Tool Frame Setting

This subsection explains how to set a tool frame on the calibration grid that is mounted on the robot end of arm tooling.



Example of tool frame setting with a pointer tool

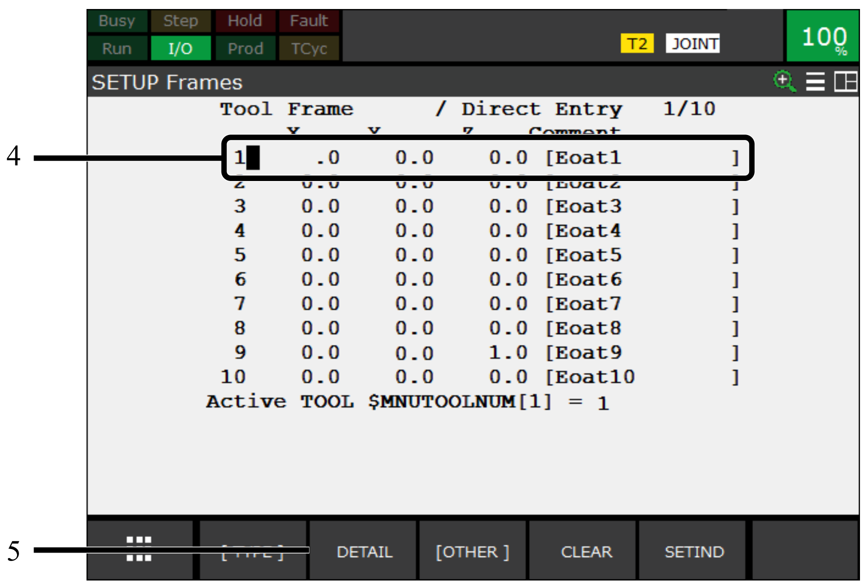
After the pointer for touch-up is secured to a secured stand, select “Tool Frame Setup / Six Point (XY)” or “Tool Frame Setup / Six Point (XZ),” and teach the six points shown in the figure below by touch-up operation. The position of the fixed pointer can be set as desired.



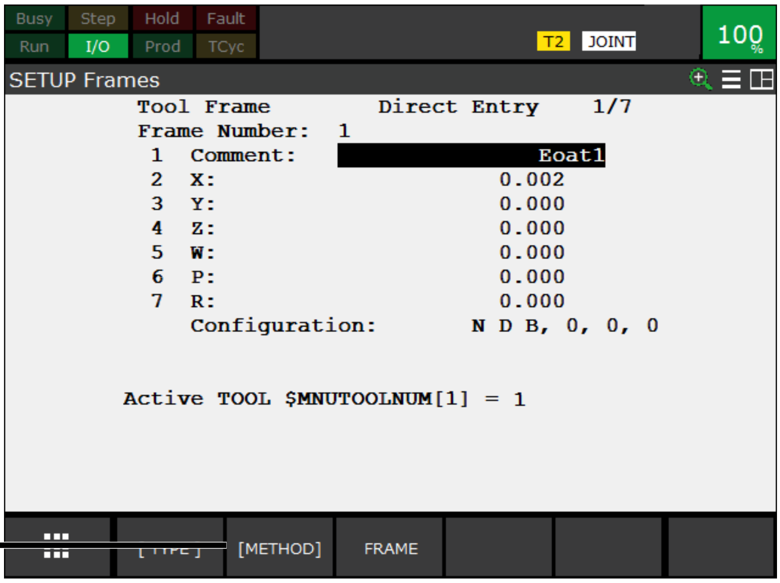
Six point teaching method touch-up points for a calibration grid

The tool frame set using the “Tool Frame Setup / Six Point (XZ)” method is rotated by 90 degrees about the X-axis with respect to a desired frame. Upon completion of setting the tool frame with the touch-up operation, manually enter the value of W plus 90.
In the example of this subsection, “Tool Frame Setup / Six Point (XY)” is explained. Make sure that the calibration grid is fixed securely to the robot end of arm tooling so that it remains in place while the robot moves. Positioning pins or other appropriate means may be used so that the calibration grid can be mounted at the same position for each measurement. Moreover, set the tool frame accurately on the calibration grid. If the accuracy of this frame setting is low, the precision in handling of a workpiece by the robot is also degraded.

1 On the teach pendant, after selecting the [MENU] key → [SETUP], place the cursor over [Frames] and press the [ENTER] key.
2 Press F3 [OTHER].
3 Place the cursor over [Tool Frame] and press the [ENTER] key.
The list screen for tool frames will appear.

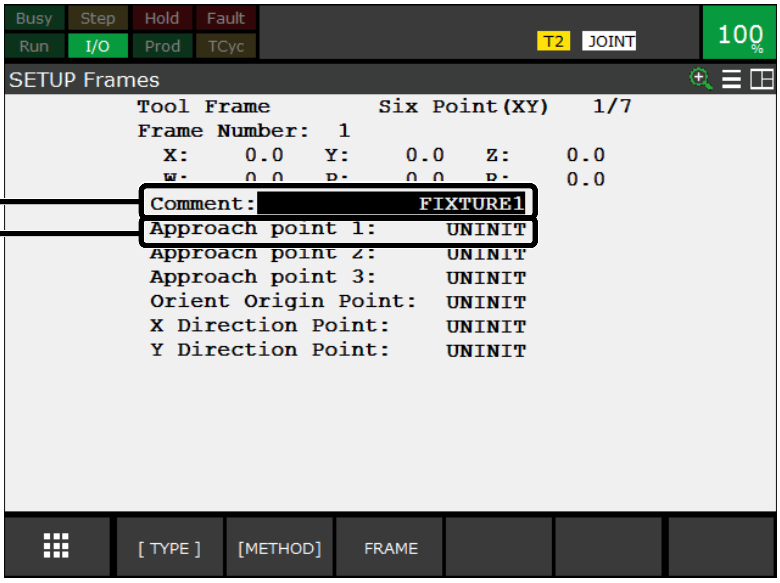


4 Place the cursor over the line of the tool frame number to be set.
5 Press F2 [DETAIL].
The setup screen for the tool frame for the selected frame number will appear.



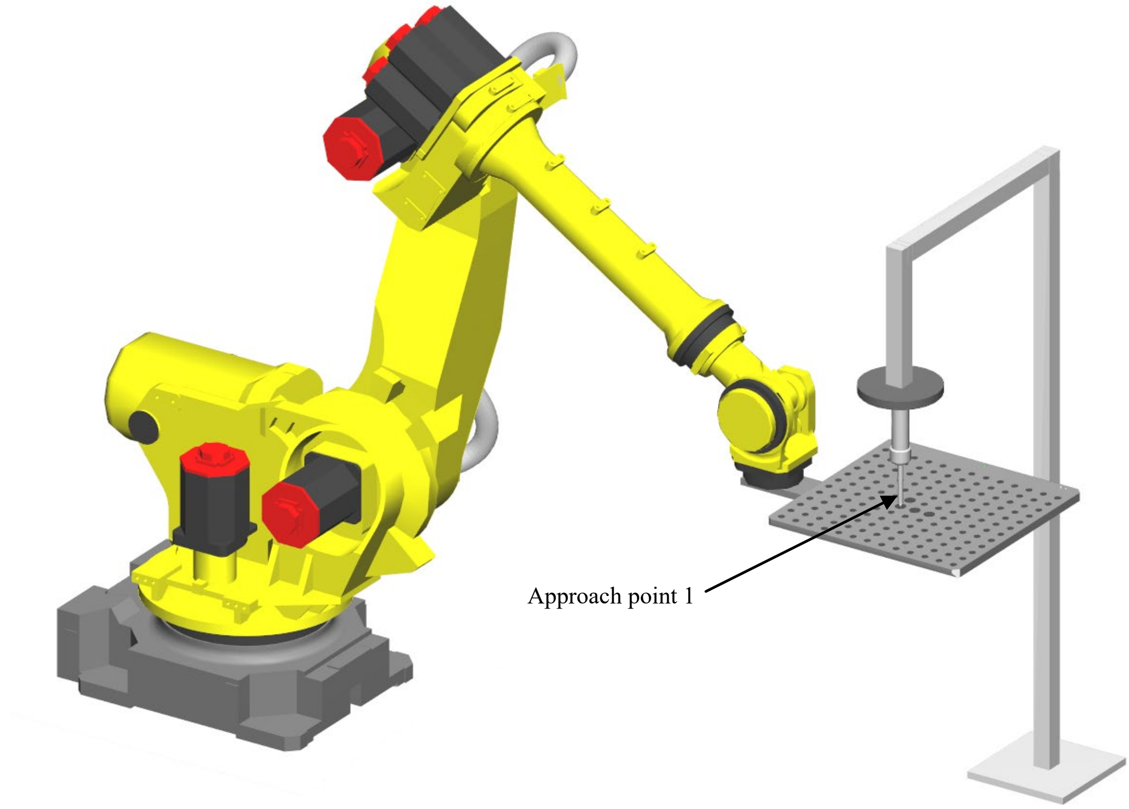
6

6 Press F2 [METHOD].
7 Place the cursor over [Six Point (XY)] and press the [ENTER] key.
A screen for tool frame setting using six points will appear.

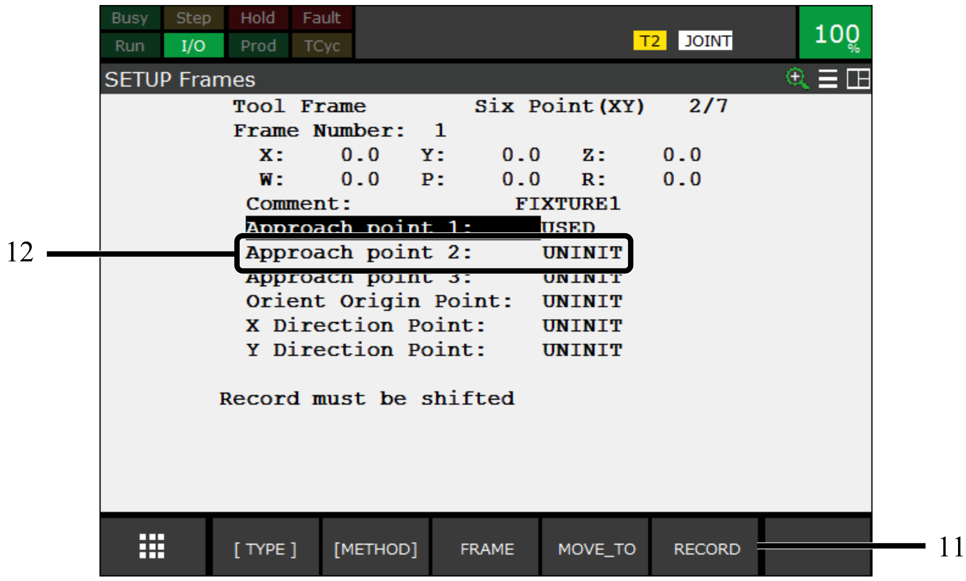


8
9

8 Enter a comment in the [Comment] field as necessary.
A comment to distinguish this frame from other frames is recommended.
9 Place the cursor over [Approach point 1].
10 Jog the robot and touch up the approach point 1 with the pointer tool.



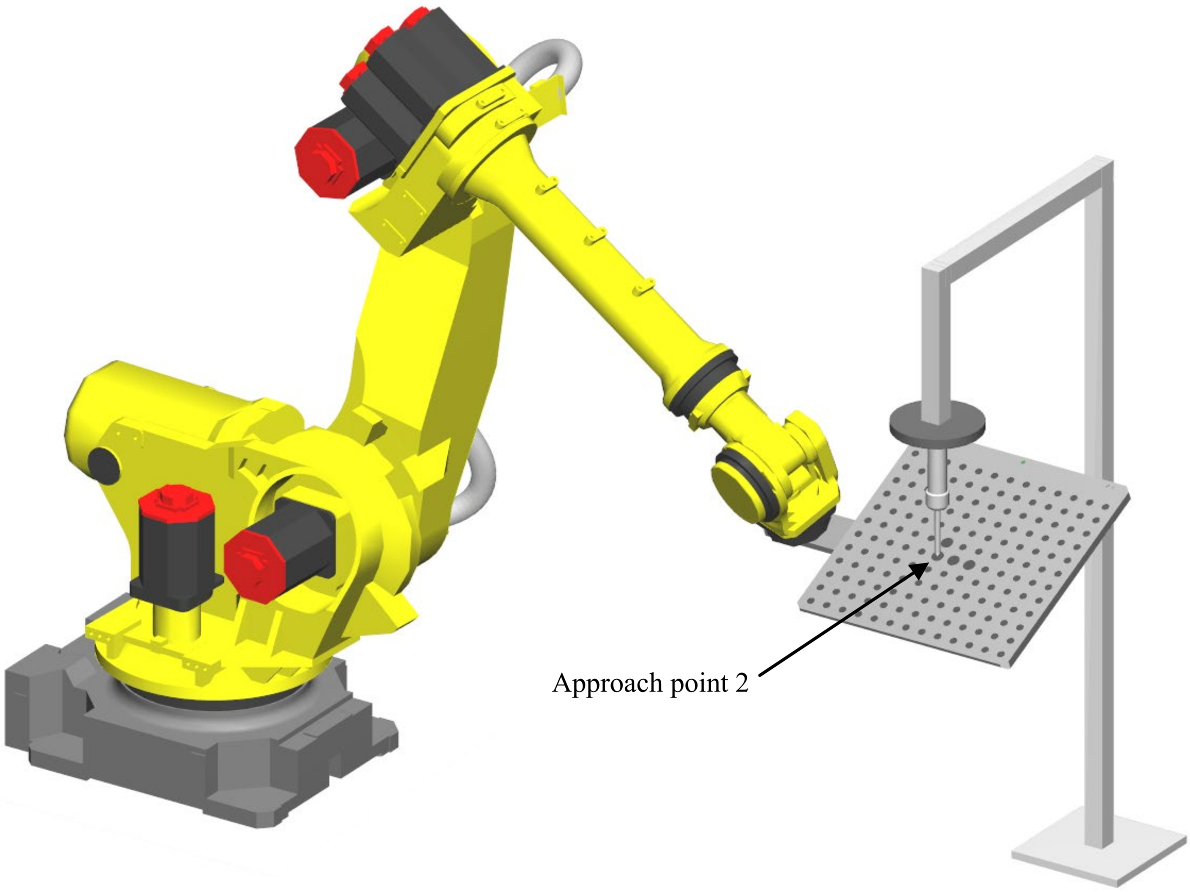
Touch-up of approach point 1



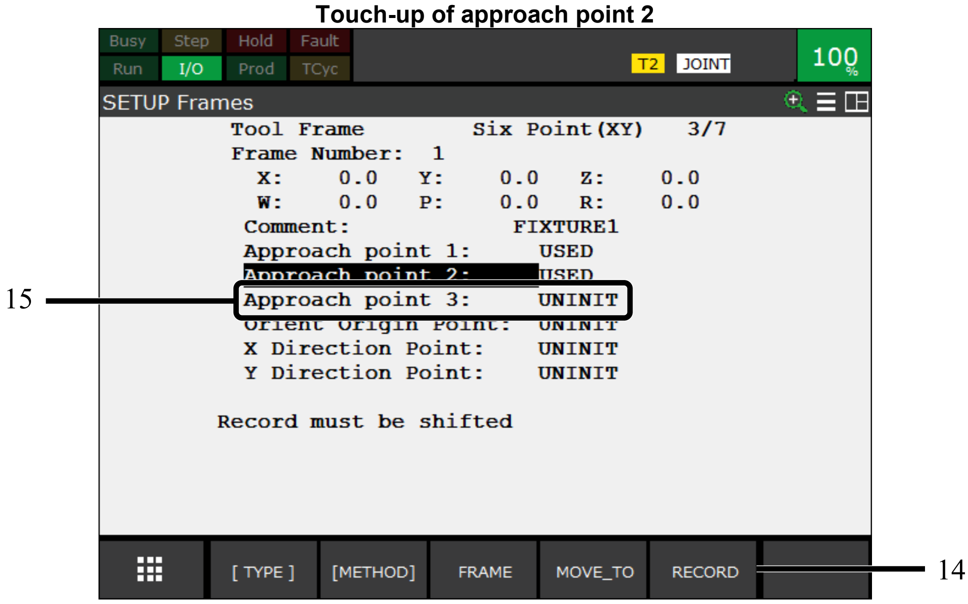
11 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 1.
[Used] will appear for [Approach point 1].

12 Place the cursor over [Approach point 2].

13 Jog the robot and touch up the approach point 2 with the pointer tool.
Touch up the same point as approach point 1. However, change the robot orientation from that of approach point 1.



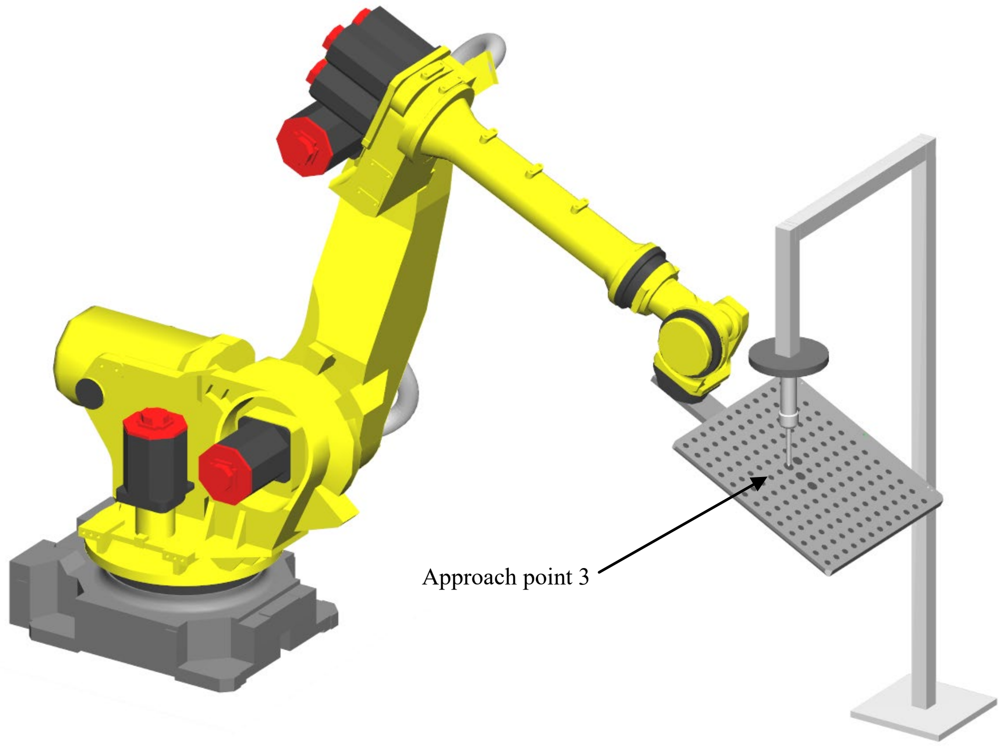
Touch-up of approach point 2



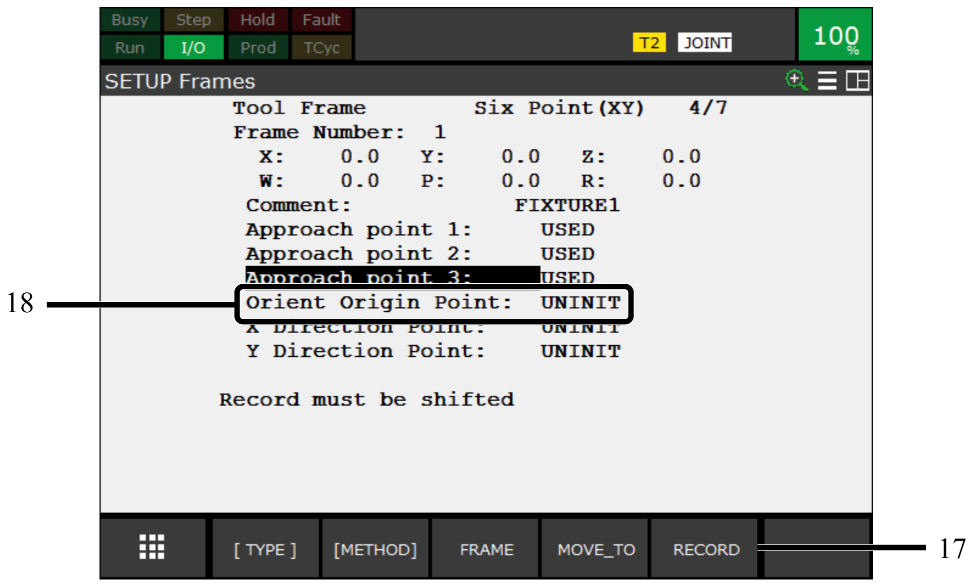
14 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 2.
As for the [Approach point 2], [USED] will appear.

15 Move the cursor to [Approach point 3].

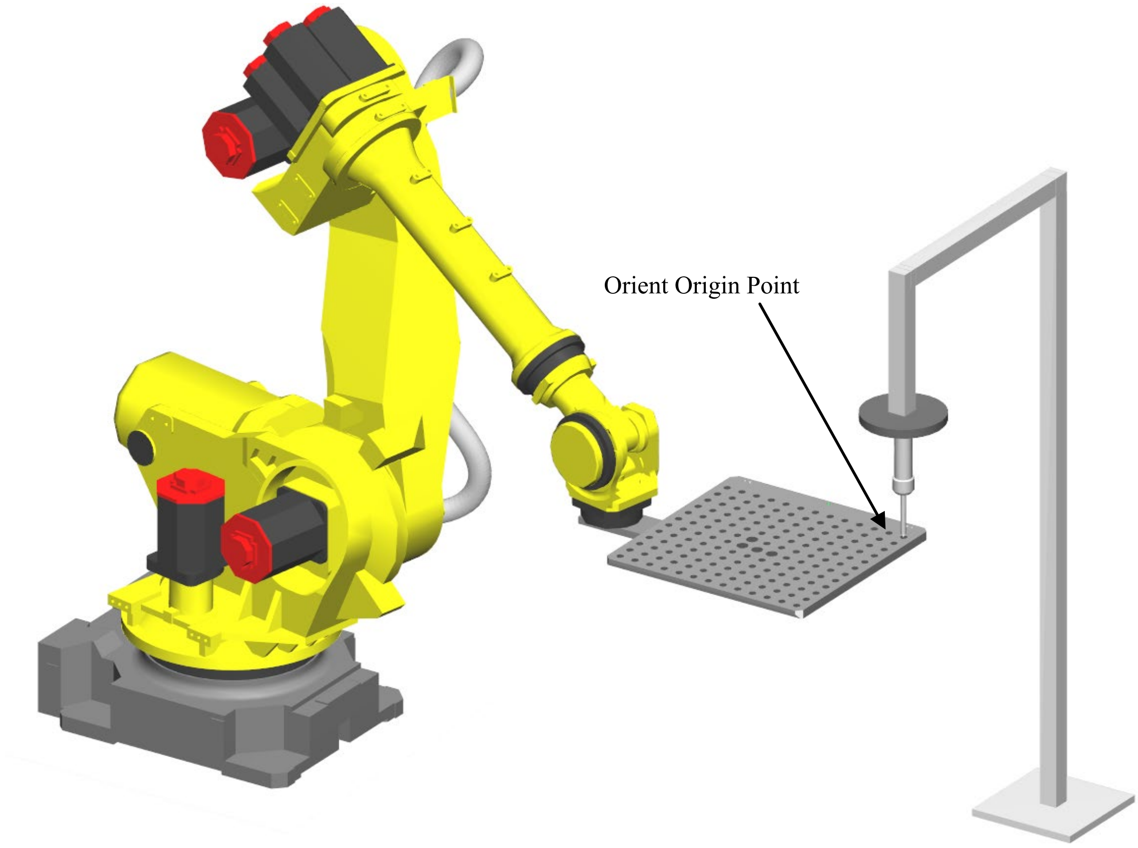
16 Jog the robot and touch up the approach point 3 with the fixed pointer.
The position of approach point 3 is the same as approach point 1 and 2. However, the posture of approach point 3 is different from the posture of approach point 1 and 2.



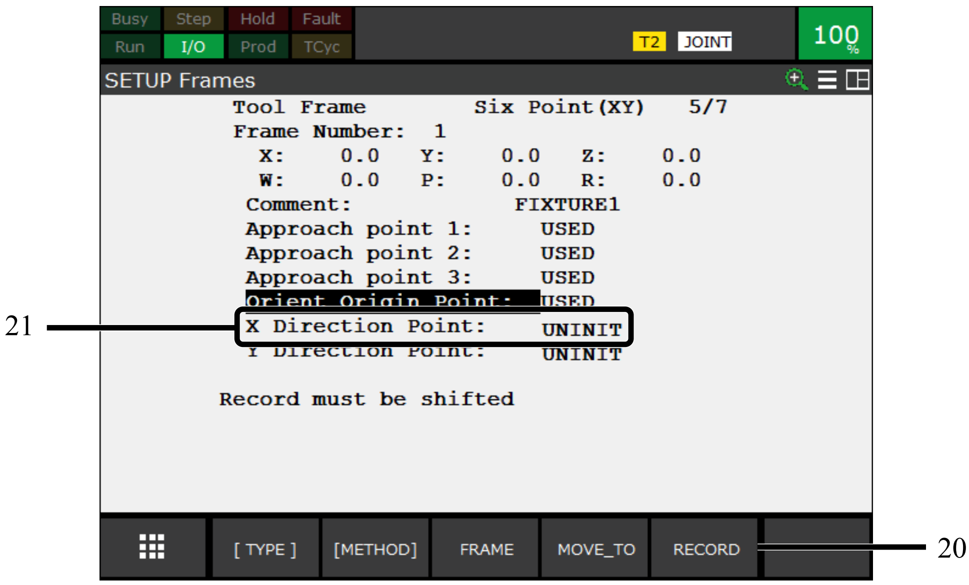
Touch-up of approach point 3



17 While holding down the [SHIFT] key, press F5 [RECORD].
The current value's data will be input as approach point 3.
As for the taught [Approach point 3], [USED] will appear.
18 Move the cursor to the [Orient Origin Point].
19 Jog the robot and touch up the Orient Origin Point with the fixed pointer.



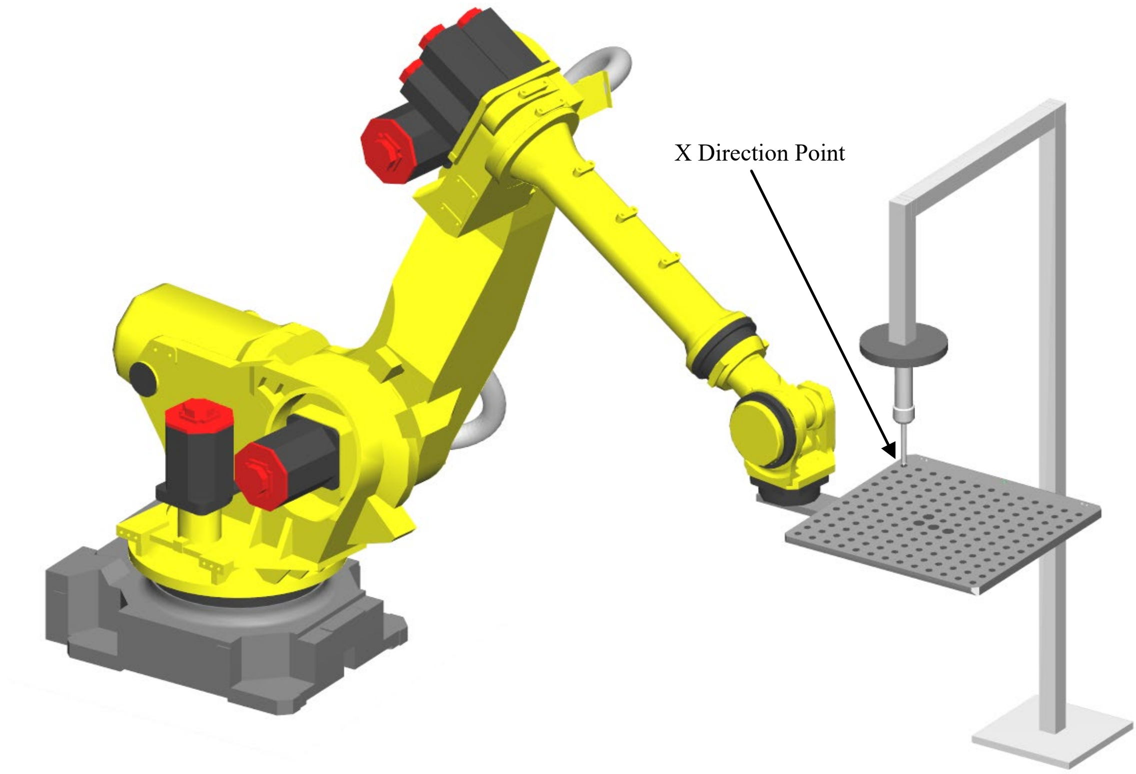
Touch-up of the point for the Orient Origin Point



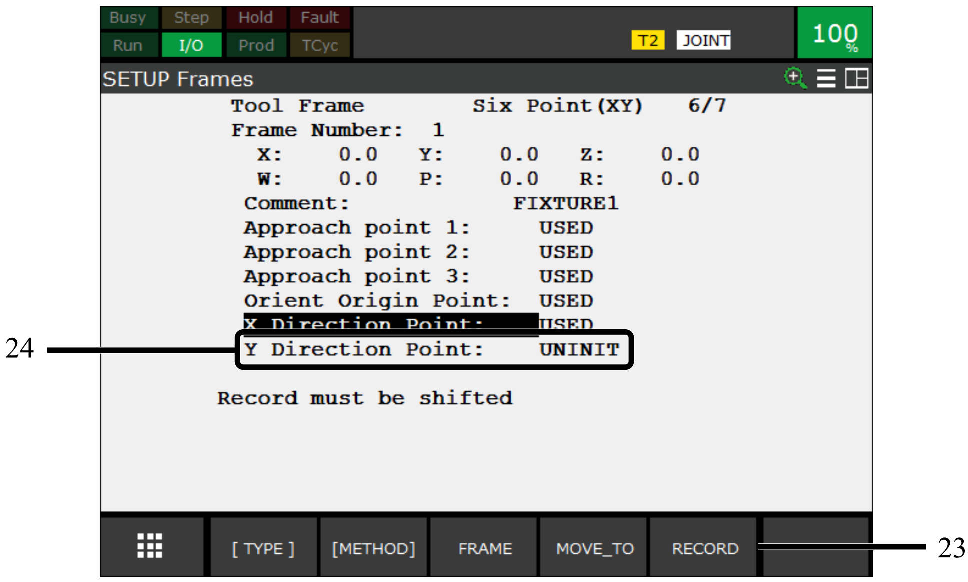
20 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the orient origin of the frame.
As for the taught [Orient Origin Point], [USED] will appear.

21 Move the cursor to the [X Direction Point].

22 Jog the robot and touch up the X Direction Point with the fixed pointer.



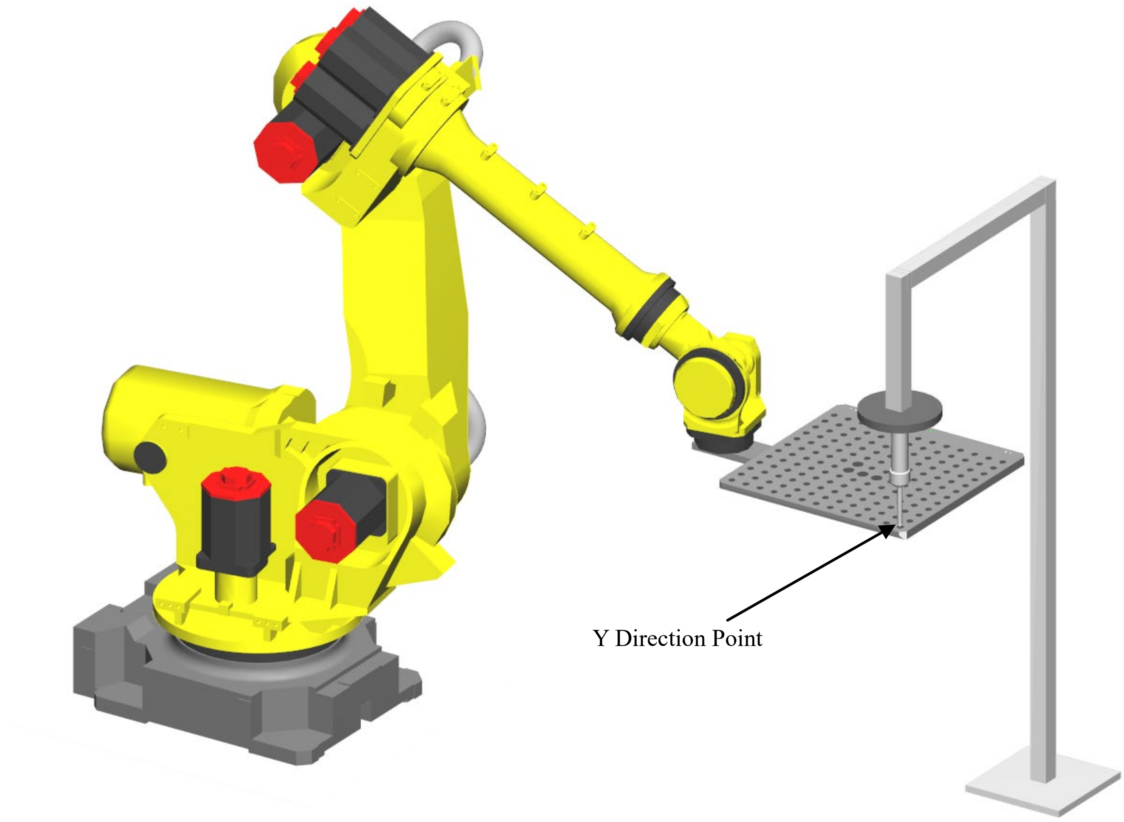
Touch-up of X direction point



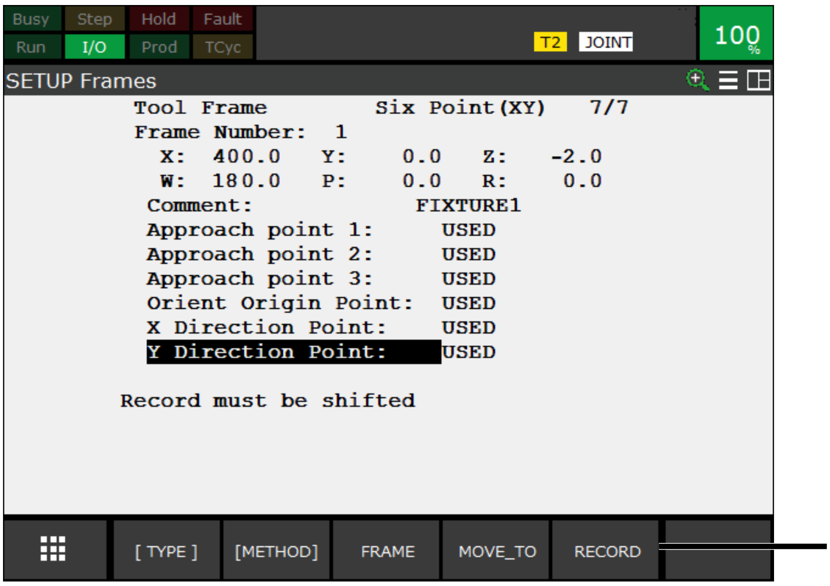
23 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the X direction point.
[USED] will appear for [X Direction Point].

24 Move the cursor to the [Y Direction Point].

25 Jog the robot and touch up the Y Direction Point with the fixed pointer.



Touch-up of Y direction point



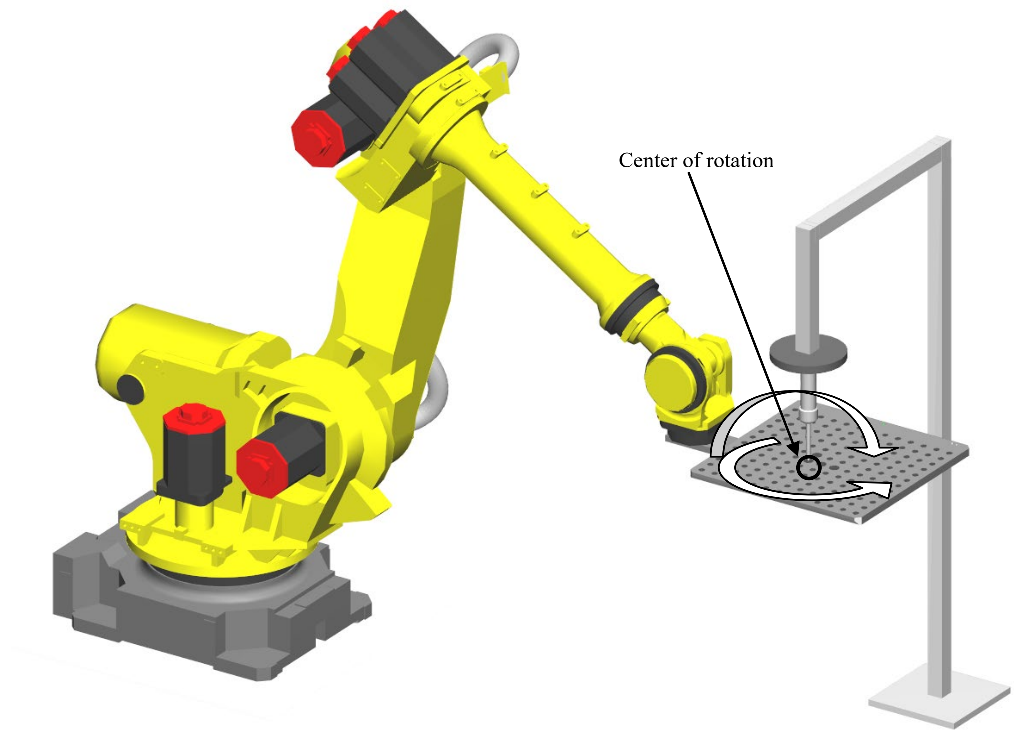
26

26 While holding down the [SHIFT] key, press F5 [RECORD].
The current position data will be recorded as the Y direction point.
When all the reference points are taught, [USED] will appear. The tool frame has been set.

27 Press the [PREV] key.
The list screen for tool frames will appear.

28 Check that the TCP is set accurately. Press F5 [SETIND] and enter a frame number.
The tool frame that has been set will be set as the currently enabled tool frame.

29 Jog the robot to move the origin point of the calibration grid close to the tip of the fixed pointer tool.



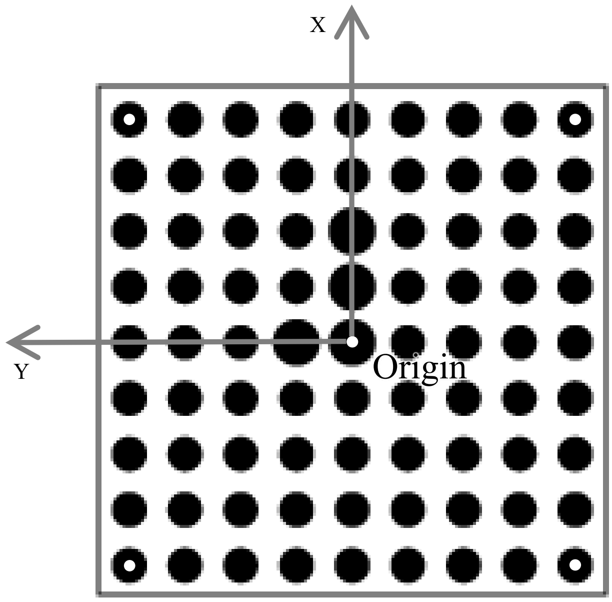
Check by moving the origin point of the calibration grid close to tip of fixed pointer tool

30 Jog the robot around the tool frame, and change the orientation of the calibration grid (w, p, r). If the TCP is accurate, the tip of the pointer tool will always point toward the origin point of the calibration grid.

1.2 FRAME SETTING WITH GRID FRAME SETTING FUNCTION

Function overview

The calibration grid frame setting function sets the calibration grid frame using a camera. In the calibration grid frame setting function, the robot holding the camera or the robot holding calibration grid automatically moves to change relative position and orientation between the camera and the calibration grid, and find the grid pattern repeatedly. Finally, the position of the calibration grid frame relative to the robot base frame or the robot mechanical interface frame (the robot face place) is identified. When the calibration grid frame setting function is executed, a frame is set on the calibration grid, as shown in the following figure.



Example of frame using calibration grid

Compared with the manual touch-up setting method, this function offers a number of merits, including accurate setting of the frame without requiring user skills, no need for touch-up pointers or to set the TCP for touch-up setting, and semi-automatic easy operation.

There are the following two methods for the calibration grid frame setting.

- Opening the camera data edit screen on the teach pendant and automatically measuring the position information of a calibration grid.
- Perform the calibration grid frame setting on the [*i*RVision Utilities] screen on the teach pendant.

When you want to quickly perform camera calibration, the method to automatically measure the position information of a calibration grid on the camera data edit screen is convenient. However, it cannot be done from the camera edit screen on your PC. It must be done by opening *i*RVision's camera edit screen from the teach pendant.

> ⚠ **CAUTION**
> The calibration grid frame setting function is usable with 6-axis robots only. The function cannot be used with 4-axis robots and 5-axis robots.

> ✐**Memo**
> The frame obtained through a calibration grid frame setting performed on the camera data edit screen will not be set to the user frame or tool frame. The obtained frame is stored inside the camera data and is used for the calibration of the camera data. Although this method is convenient when you only want to perform a calibration of camera data, to set a user frame or tool frame on the calibration grid, perform a calibration grid frame setting on the *i*RVision Utilities screen.

1.2.1 Setting Procedure Using Camera Data Edit Screen

Use the following setup procedure for the calibration grid frame setting function on the camera data edit screen:

1 Mounting calibration grid

⇩

2 Editing the camera data

⇩

3 Teaching start position (Camera data edit screen)

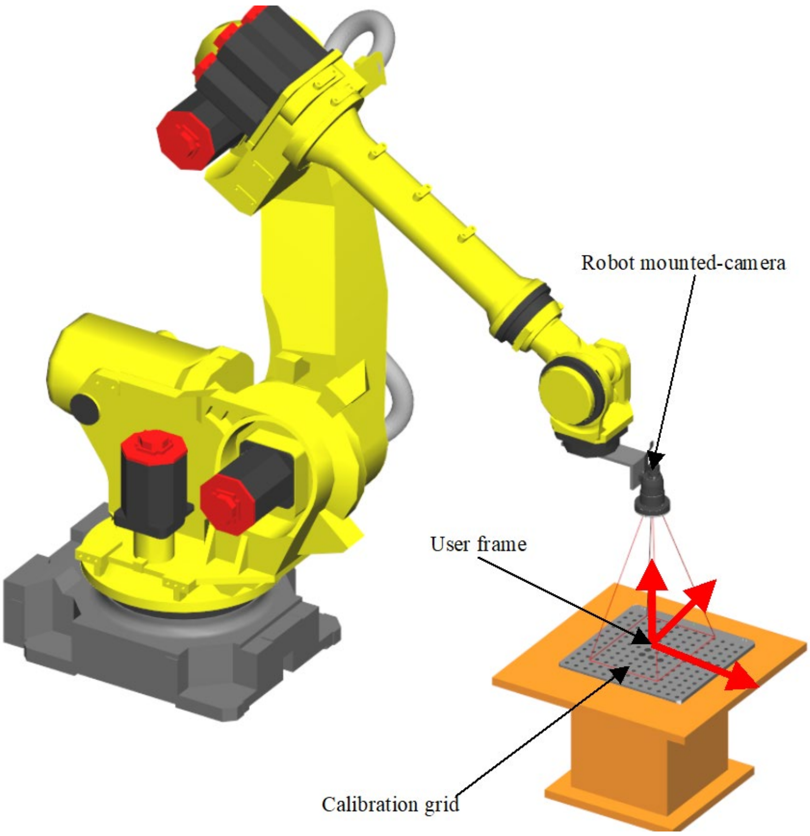
⇩

4 Running measurement (Camera data edit screen)

1.2.1.1 Mounting calibration grid

When the calibration grid is secured to a fixed surface

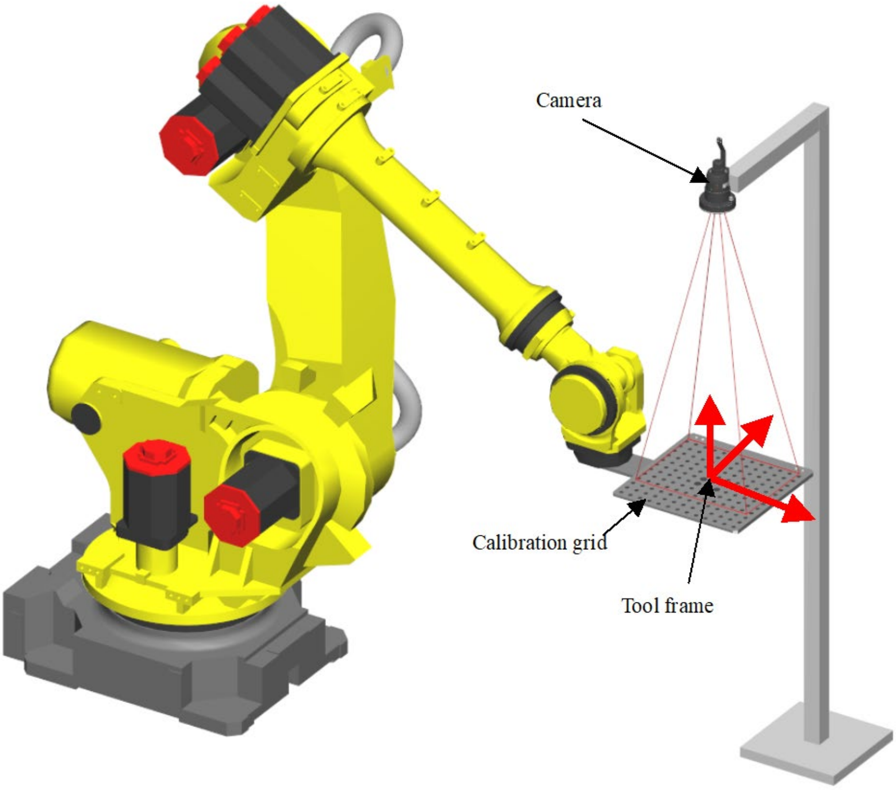
When the calibration grid is secured to fixed surface, a camera mounted on the robot end of the arm tooling is used to measure the position of the calibration grid frame. The calibration grid frame setting function identifies the position of the calibration grid frame relative to the robot base frame (world). When using a robot-mounted camera, the calibration grid frame setting function can be performed with the camera currently used. When using a fixed camera, prepare another camera for the calibration grid frame setting function.



Example of a fixed calibration grid

When the calibration grid is mounted on the robot

When the calibration grid is mounted on the robot, a fixed camera is used to measure the position of the calibration grid frame. The robot moves the calibration grid within the field of view of the fixed camera. The calibration grid frame setting function identifies the position of the calibration grid frame relative to the robot mechanical interface frame (the robot face plate). The calibration grid frame setting function can be performed with the camera currently used. When there is not enough space to perform the calibration grid frame setting function with the camera currently used, prepare another fixed camera to make it possible to perform the calibration grid frame setting function.



Example of a calibration grid attached to the robot hand

Make sure that the calibration grid is fixed securely so that it does not move during measurement.

> **Memo**
> To prevent unnecessary circles from being found, check that the calibration grid is free of dirt and flaws. Laying out a plain sheet in the background is effective. Also, make sure to cover the printed text on the calibration grid.

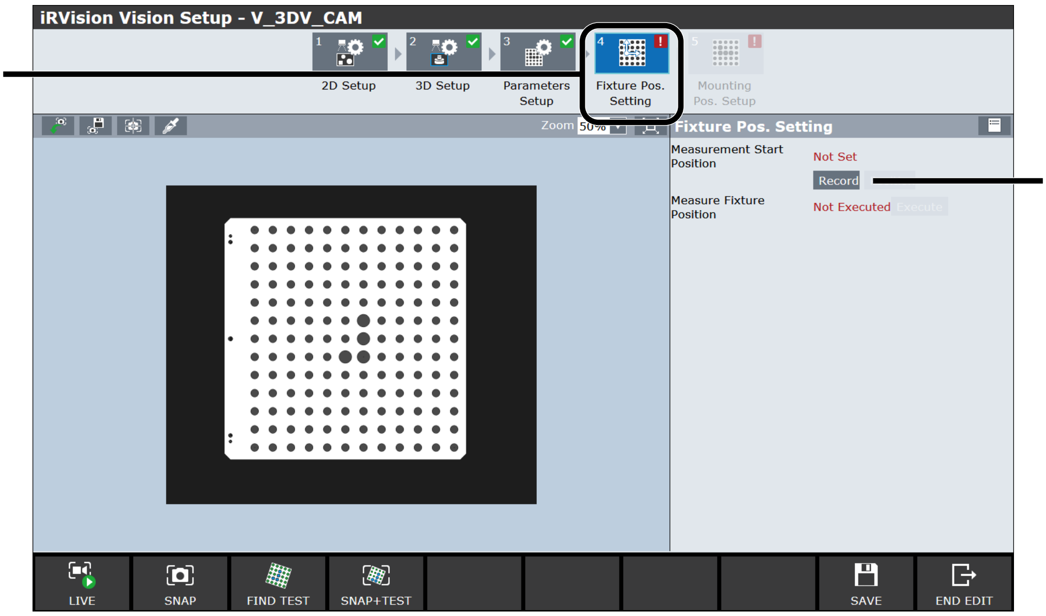
1.2.1.2 Editing the camera data

Open the camera data edit screen and configure settings to automatically measure the position information of a calibration grid.
When the  icon is shown for [1 2D Setup], [2 3D Setup], and [3 Parameters Setup] in the navigation area, the setup is complete.

For details when using a fixed camera, refer to “Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA,” or when using the robot-mounted camera, refer to “Know-How: 2.1 3DV SENSOR MOUNTING POSITION SETUP WITH ROBOT-MOUNTED CAMERA.” However, in step “Setting the Parameters,” you must select [Measure automatically] from the [Cal. Grid Frame] drop-down box.

1.2.1.3 Teaching start position

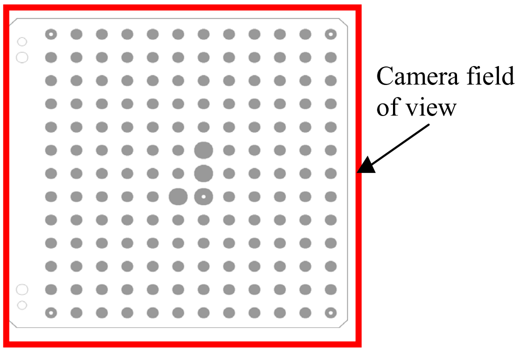
Teach the start position using the following procedure.

1


4

1 Press [4 Fixture Pos. Setting] in the navigation area.
2 Press [LIVE].
The image being snapped by the camera is shown in real time.
3 Jog the robot so that the camera’s optical axis is approximately perpendicular to the plate surface of the calibration grid and that all four of the large black circles of the calibration grid are inside the camera’s field of view. The distance between the calibration grid and the camera should be appropriate for the grid to come into focus, which is, under normal circumstances, roughly the same as the distance at which camera calibration is performed.

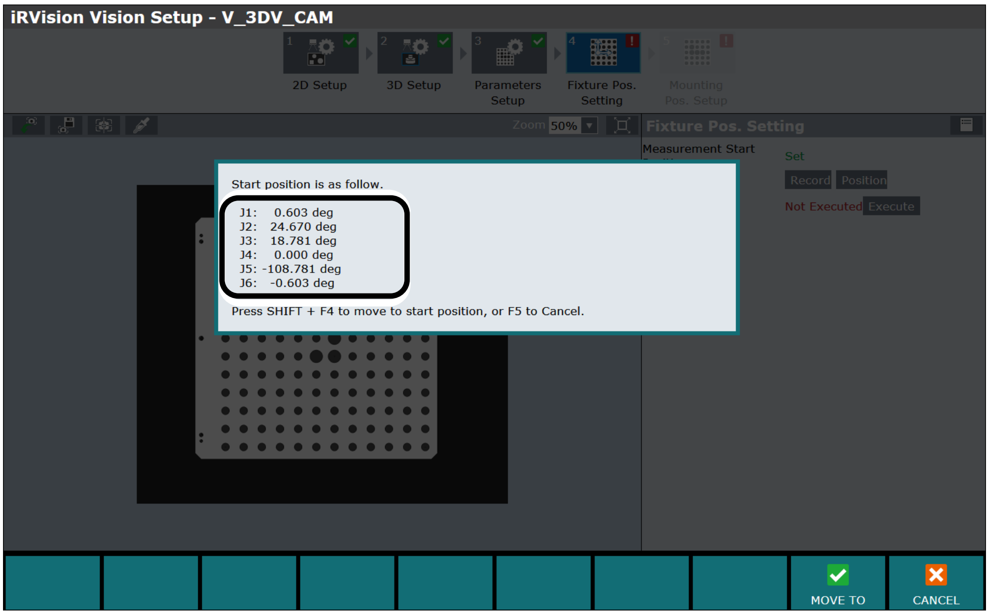
Memo
For Automatic Grid Frame Set, measurement is performed by panning and rotating the camera attached to the robot’s gripper or the calibration grid. It is recommended that you set the field of view to something quite large in relation to the calibration grid, so that the four large black circles will not be outside of the field of view.



Camera field of view

4 Press [Record] in [Measurement Start Position]
The start position will be recorded, and [Start Position] changes to [Recorded].

5 To check the trained start position, press [Loc.] in [Measurement Start Position].
The value of each axis of the start position will appear, as shown below.



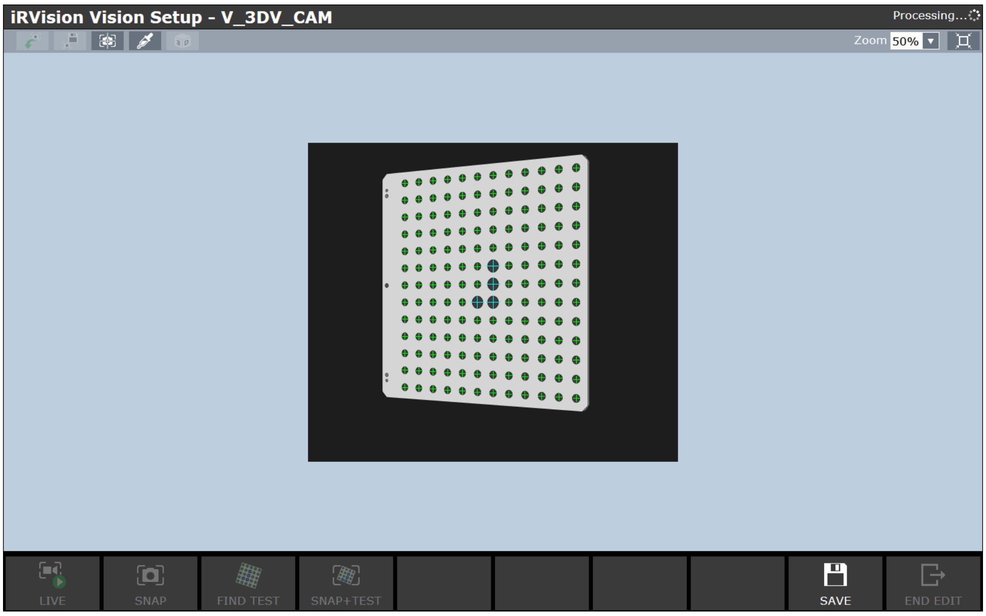
To return to the previous menu, press [CANCEL].

6 When moving the robot to the taught start position, press [OK] while pressing the [SHIFT] key on the teach pendant.

1.2.1.4 Running measurement

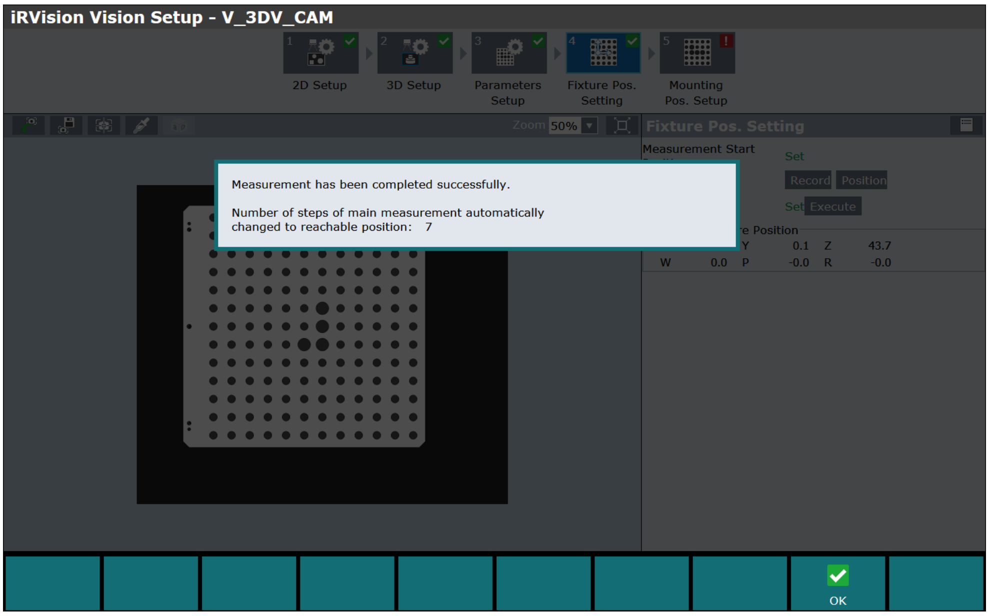
Perform measurement as follows, using the taught start position as a reference.

1 Check that the robot is at the start position.
2 While holding down the [SHIFT] key on the teach pendant, press [EXECUTE] in [Measure Fixture Position].
The robot will start the operation, and measurement will be executed. When the robot is in operation, the menu switches, allowing you to check the image being measured in real time.



> ⚠ **CAUTION**
> 1 The measurement will stop if you release the [SHIFT] key on the teach pendant during measurement.
> In such cases, redo the measurement. The measurement can be resumed from where it was stopped.
> 2 Although the robot will perform the decided motion to some extent, depending on the settings, it is possible that it will move with an unexpected motion range.
> When executing measurement, check that the setup of parameters is correct, and be careful to lower the override so that the robot will not interfere with devices.
> 3 The robot may not be able to operate if other programs are in a paused state. In such cases, press the [FCTN] key on the teach pendant and end the programs.

When the measurement is successfully completed, a menu like the one shown below appears.
The robot stops after moving to a position where the camera directly faces the calibration grid and the origin of the calibration grid comes to the center of the image.



Checking measurement result

When the measurement is completed, the settings of the calibration grid are shown on the screen. You can check if there is a problem with the displayed settings using the following procedure.

1 Set the displayed position information to a frame number that has yet to be set.
When the calibration grid is robot-mounted, set the information to the tool frame.
When the calibration grid is fixed, set the information to the user frame.

> **Memo**
> Set the displayed position information on the frame setting screen on the teach pendant.

2 Switch to the frame set in step 1.
3 Set the manual feed frame to the frame set in step 1.
For a tool frame, press the [COORD] key and switch to [Tool].
For a user frame, press the [COORD] key and switch to [User].
4 Press the  icon in the image display area on the camera data edit screen.
5 Press [LIVE] on the camera data edit screen.
6 Jog the robot around the WPR. There will be no problem unless the center position of the grid pattern is significantly far from the center line of the image.

In the event of failure to measure

If the measurement fails, the screen returns to the camera data edit screen without displaying a message on the completion of measurement.
Review the setting items, [1 2D Setup], [3 Parameter Setup], and [4 Cal. Grid Location] or the start position and redo the measurement. For details, refer to the description of setting the fixture position (Measure Automatically) in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN".

1.2.2 Setting Procedure Using *i*RVision Utilities Screen

Use the following setup procedure for the calibration grid frame setting function on the *i*RVision Utilities screen:

1. Mounting the calibration grid

⇩

2. Setting the Parameters

⇩

3. Teach the start position

⇩

4. Run measurement

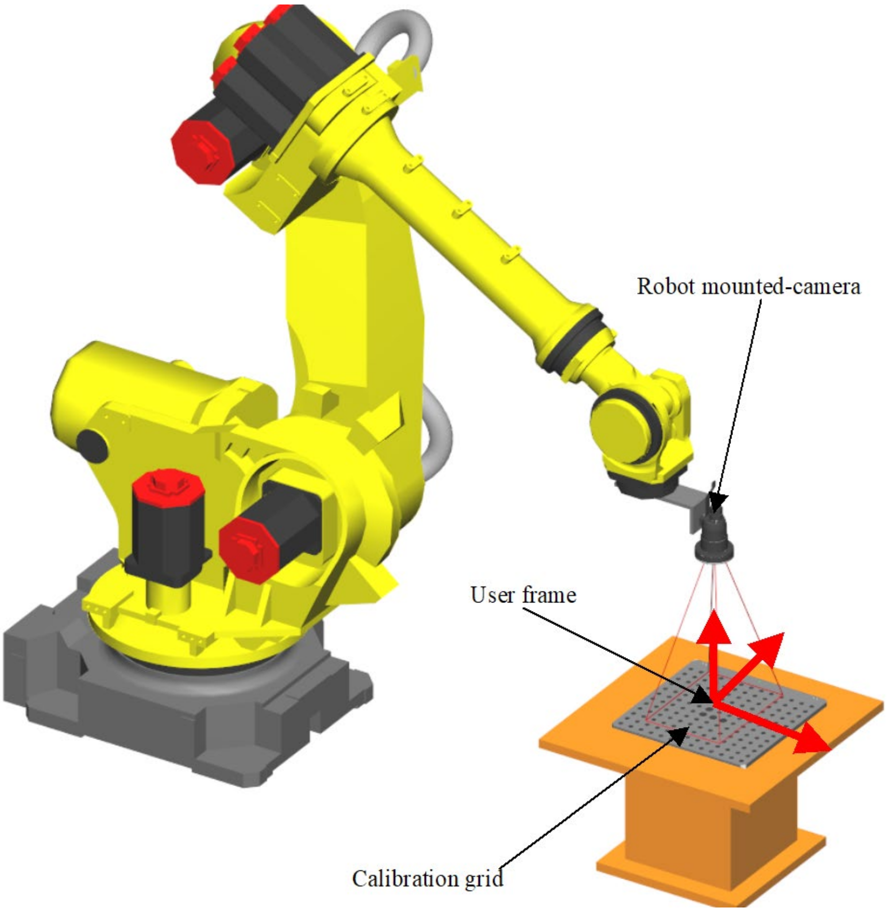
Setup flow

1.2.2.1 Mounting calibration grid

When the calibration grid is secured to a fixed surface

When the calibration grid is secured to fixed surface, a camera mounted on the robot end of the arm tooling is used to measure the position of the calibration grid frame. The calibration grid frame setting function identifies the position of the calibration grid frame relative to the robot base frame (world), and sets the results in a user specified user frame. When using a robot-mounted camera, the calibration grid frame setting function can be performed with the camera currently used. When using a fixed camera, prepare another camera for the calibration grid frame setting function.

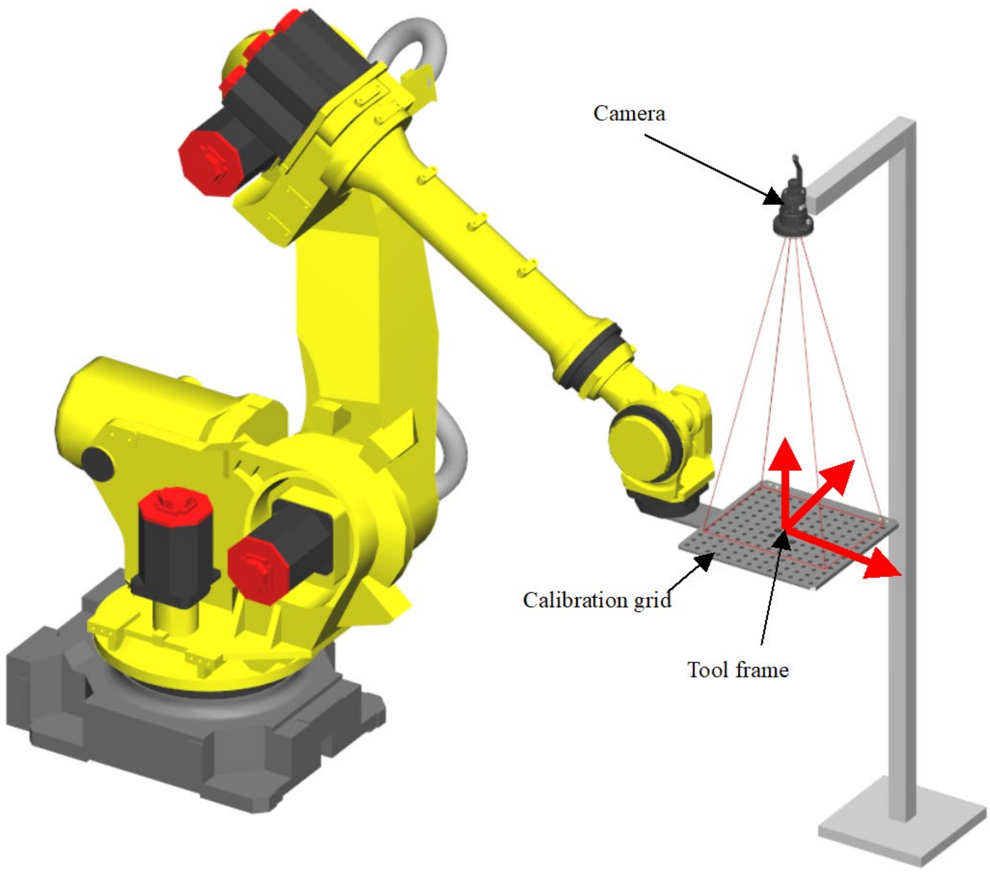
> ✐**Memo**
> When you want to set the position information of a calibration grid to calibrate the robot-mounted camera, the method to automatically measure the position information on the camera data edit screen is convenient.



Example of a fixed calibration grid

When the calibration grid is mounted on the robot

When the calibration grid is mounted on the robot, a fixed camera is used to measure the position of the calibration grid frame. The robot moves the calibration grid within the field of view of the fixed camera. The calibration grid frame setting function identifies the position of the calibration grid frame relative to the robot mechanical interface frame (the robot face plate), and the results is written in a user defined tool frame. The calibration grid frame setting function can be performed with the camera currently used. When there is not enough space to perform the calibration grid frame setting function with the camera currently used, prepare another fixed camera to make it possible to perform the calibration grid frame setting function.



Example of a calibration grid attached to the robot hand

Make sure that the calibration grid is fixed securely so that it does not move during measurement.

Memo
To prevent unnecessary circles from being found, check that the calibration grid is free of dirt and flaws. Laying out a plain sheet in the background is effective. Also, make sure to cover the printed text on the calibration grid.

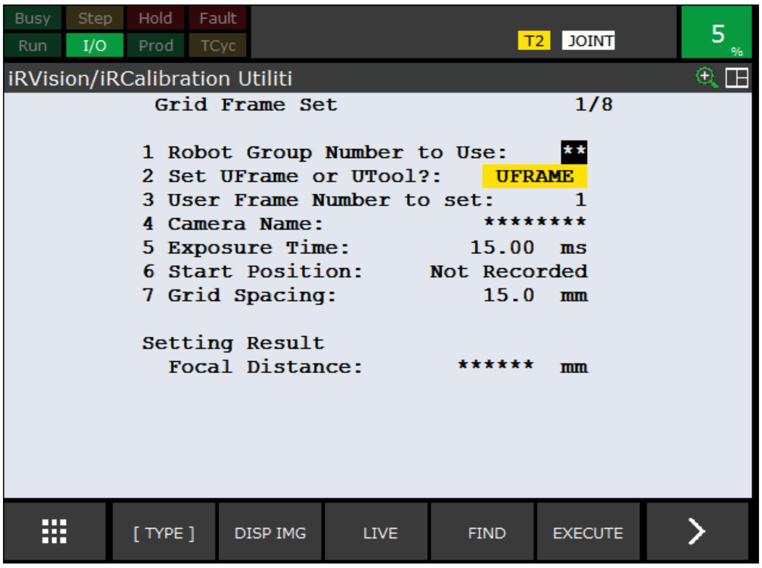
1.2.2.2 Setting parameters

Setup the parameters on the [*i*RVision Utilities] screen of the teach pendant.

1 On the teach pendant, after selecting the [MENU] key → [iRVision], place the cursor over [Vision Utilities] and press the [ENTER] key.
The [*i*RVision Utilities] screen will appear.

2


2 Place the cursor over [Automatic Grid Frame Set] and press the [ENTER] key.
The [Grid Frame Set] screen will appear.



> ⚠ **CAUTION**
> The Grid Frame Set menu cannot be opened in more than one window at a time.

The following items will appear on the [Grid Frame Set] screen.

[Robot Group Number to Use]

Specify the group number of the robot to be used for measurement.

[Set UFrame or UTool?]

Select the frame to be set with the calibration grid frame setting function - user frame or tool frame. To set the tool frame with the calibration grid mounted on the robot, select F4 [UTOOL]. To set the user frame with the calibration grid secured to a table or other fixed surface, select F5 [UFRAME].

[User Frame Number to set]

Specify the number of the user frame to be set. The range of specifiable user frame numbers is 1 to 9. This will only appear if [UFRAME] is selected in [Set UFrame or UTool?].

[Tool Frame Number to set]

Specify the number of the tool frame to be set. The range of specifiable tool frame numbers is 1 to 10. This will only appear if [UTOOL] is selected for [Set UFrame or UTool?].

[Camera Name]

Select a camera to use in the measurement. Place the cursor over the line of [Camera Name], then press F4 [CHOICE], and a list of cameras will appear. By selecting from the list, specify the camera to use for the measurement.

[Exposure Time]

Specify the exposure time for the camera to capture an image (Shutter speed). The larger the value, the brighter the images that will be snapped.
Adjust the exposure time so that the black circles of the calibration grid are clearly visible.

[Start Position]

Teach the position where measurement is to be started. If the position has been taught already, [Recorded] will appear, and if it hasn't been, [Not Recorded] will appear.
In the case of [Not Recorded], measurement cannot be executed. Be sure you always teach the start position before measurement.
For the procedure to teach the start position, refer to “Know-how: 1.2.1.3, Teaching start position.”

[Grid Spacing]

Set the grid spacing of the calibration grid in use.

[Setting Result]

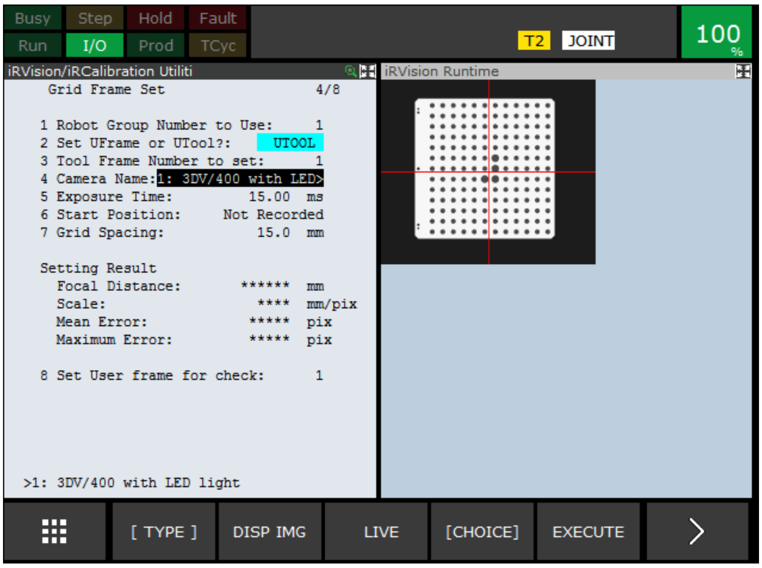
This item is displayed when the measurement is complete. For details, refer to the description of checking the measurement result in “*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN.”

[Set Tool/User Frame for check]

This item can be set after the completion of measurement. It cannot be set when the measurement has not been completed. For details, refer to the description of checking the measurement result in “*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN.”

F2 [DISP IMG]

Pressing F2 [DISP IMG] displays the Grid Frame Set screen and Vision Runtime screen as follows.



F3 [LIVE]

A live image for the selected camera will appear on the Vision Runtime screen. When a live image appears, it changes to F3 [STOPLIVE] and if F3 [STOPLIVE] is pressed, live image display will be stopped.

F4 [FIND]

Performs detection of a grid pattern. The detection result will be displayed on the Vision Runtime screen.

F7 [DEFAULT]

The set values will be changed to the initial values. [Camera Name] and [Start Position] will be returned to their initial values so that you can set them again.

F8 [LED TYPE]

The setting screen for the LED light integrated in the camera package will be displayed. For details on LED light setting, refer to the description of setting the LED light in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

F9 [MOVE_LIM]

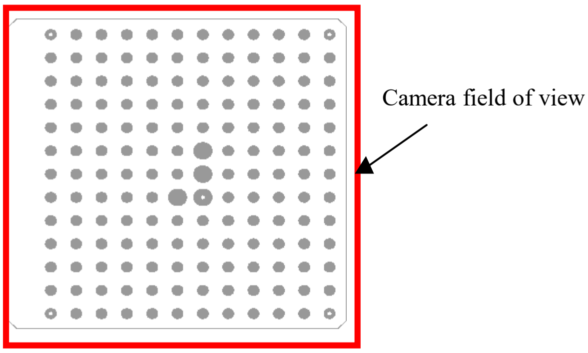
The robot moves during measurement of a calibration grid frame. A setting screen will appear to limit the amount of such movement. For details on the move amount limit setting, refer to the description of setting the moving limit in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

1.2.2.3 Teaching start position

Teach the start position using the following procedure.

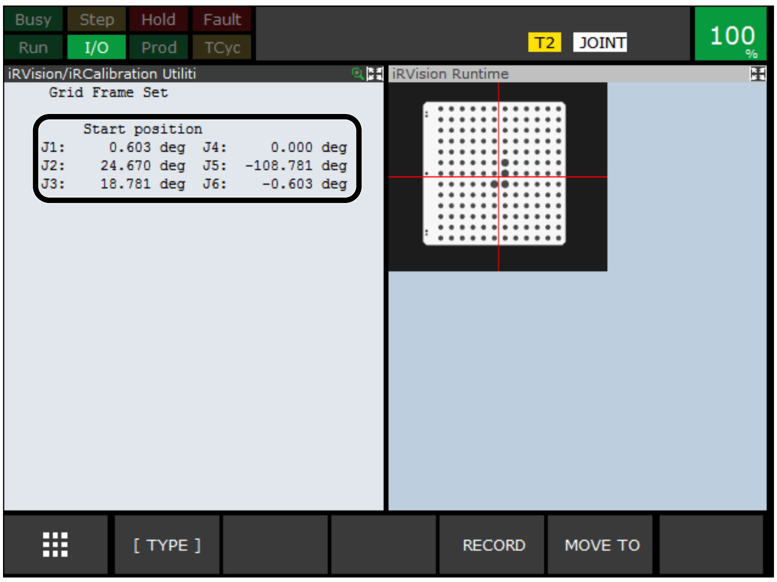
1 If Vision Runtime does not appear, press F2 [DISP IMG].
2 Place the cursor over [Start Position].
3 Jog the robot so that the camera's optical axis is approximately perpendicular to the plate surface of the calibration grid and that all four of the large black circles of the calibration grid are inside the camera's field of view. The distance between the calibration grid and the camera should be appropriate for the grid to come into focus, which is, under normal circumstances, roughly the same as the distance at which camera calibration is performed.

> **Memo**
> For Automatic Grid Frame Set, measurement is performed by panning and rotating the camera attached to the robot's gripper or the calibration grid. It is recommended that you set the field of view to something quite large in relation to the calibration grid, so that the four large black circles will not be outside of the field of view.



Camera field of view

4 While holding down the [SHIFT] key, press F4 [RECORD].
The start position will be recorded, and [Start Position] changes to [Recorded].
5 To check the trained start position, press F3 [POSITION].
The value of each axis of the start position will appear, as shown below.



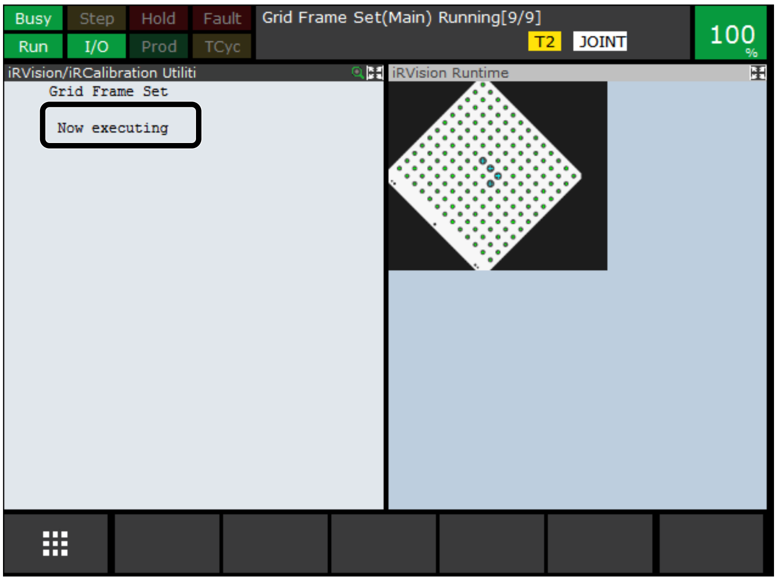
To return to the previous menu, press the [PREV] key.

6 When moving the robot to the taught start position, press F5 [MOVE TO] while pressing the [SHIFT] key.

1.2.2.4 Running measurement

Perform measurement as follows, using the taught start position as a reference.

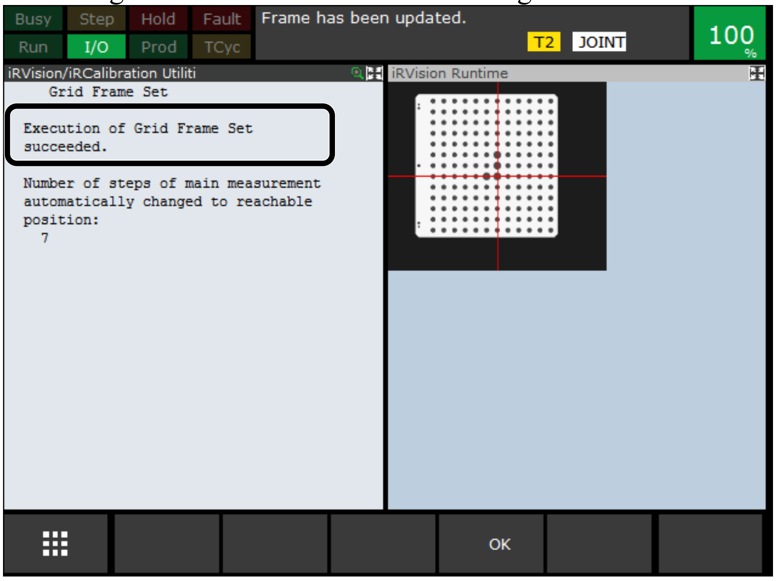
1 If Vision Runtime does not appear, press F2 [DISP IMG].
2 Check the parameter setup on the [Automatic Grid Frame Set] screen.
3 Check that the robot is at the start position.
4 While holding down the [SHIFT] key, press F5 [EXECUTE].
The robot will start the operation, and measurement will be executed. A message saying 'Now executing' will appear during the operation.



⚠ CAUTION

1 The measurement will stop if you release the [SHIFT] key during measurement. In such cases, redo the measurement. The measurement can be resumed from where it was stopped.
2 The measurement will stop if you perform an operation that moves to another screen during measurement, such as pressing the [SELECT] key on the teach pendant. In such cases, open the [Automatic Grid Frame Set] screen and redo the measurement. The measurement can be resumed from where it was stopped.
3 Although the robot will perform the decided motion to some extent, depending on the settings, it is possible that it will move with an unexpected motion range. When executing measurement, check that the setup of parameters is correct, and be careful to lower the override so that the robot will not interfere with devices.
4 The robot may not be able to operate if other programs are in a paused state. In such cases, press the [FCTN] key and end the programs.

When the measurement is successfully completed, a menu like the one shown below appears.
The robot stops after moving to a position where the camera directly faces the calibration grid and the origin of the calibration grid comes to the center of the image.



5 If you press F4 [OK], you will return to the Automatic Grid Frame Set screen.

Checking measurement result

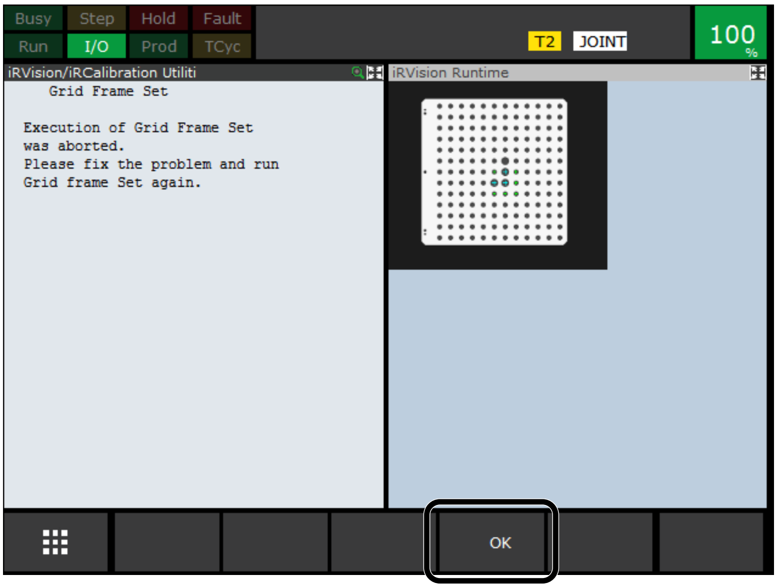
The calibration grid frame will be set depending on the measurement. The set frame can be checked using the following procedure.

1 Set the manual feed frame as the frame for automatic grid frame set.
For a tool frame, press the [COORD] key and switch to [Tool].
For a user frame, press the [COORD] key to switch to [User], and specify the tool frame number that was specified in [Camera User Tool Number] in [Tool] under the jog menu, using the number keys.

2 Press F3 [LIVE] to start the display of a live image, and move the robot by jog operation around the WPR of the selected tool frame. There will be no problem unless the center position of the grid pattern is significantly far from the center line of the image.

In the event of failure to measure

If measurement fails, the following message will appear.



If F4 [OK] is pressed, the screen will return to the original screen.
After changing the setup parameters, measurement can be redone by pressing F5 [EXECUTE] while holding down the [SHIFT] key.

2 3DV SENSOR DATA SETTING

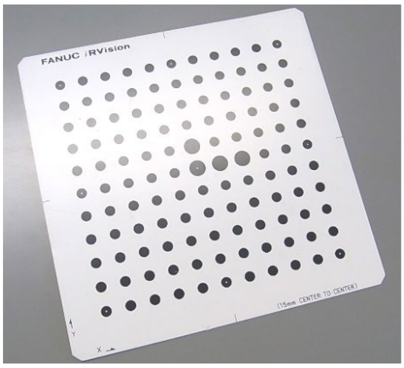
This chapter explains the settings for 3DV Sensor Data.
Create 3DV Sensor Data and perform camera setup and mounting position setup. Mounting Position Setup is the task of setting where the 3DV Sensor is installed as seen from the robot. Complete mounting position setup before teaching a vision process. There are two mounting position setup methods for the 3DV Sensor. This chapter explains them using the following system configuration.

- "Know-How: 2.1 3DV SENSOR MOUNTING POSITION SETUP WITH ROBOT-MOUNTED CAMERA"
- "Know-How: 2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA"

> ⚠ **CAUTION**
> The appropriate distance between a 3DV Sensor and the calibration grid is dependent on the standoff distance of the 3DV Sensor.
> In this chapter, 3DV/400, the standoff distance of which is about 800 mm is used as an example for explanation.

2.1 3DV SENSOR MOUNTING POSITION SETUP WITH ROBOT-MOUNTED CAMERA

To use the 3DV Sensor, mounting position setup using a calibration grid is required. When performing mounting position setup, prepare a calibration grid in advance. You would usually use a calibration grid that is bigger than the field of view. A standard calibration grid is available from FANUC in several sizes. It is strongly recommended that you order a calibration grid as well as a camera and a lens.



Calibration grid

It is not necessary to detect all the circles on the calibration grid. There are 11 x 11 circles in the standard calibration grid of FANUC. If 7 x 7 circles can be detected, calibration is performed with high accuracy (the four large circles need to be detected). There is no need to prepare a small calibration grid in order to show all the circles in the field of view. In order to perform calibration with sufficient accuracy to the edge of the field of view, even if there are fewer detectable circles, prepare a calibration grid that is bigger than the field of view.
Use the following setup procedure for 3DV Sensor mounting position setup with a robot-mounted camera.

This section explains how to automatically measure the position information of a calibration grid as an example.

⚠ **CAUTION**

1 There are certain requirements for automatically measuring the position information of a calibration grid. For details, refer to “Know-How: 1.2.1 Setting Procedure Using Camera Data Edit Screen.”
2 30 mm calibration grid spacing is recommended when using 3DV/1600.
3 7.5 mm calibration grid spacing is recommended when using 3DV/70 or 3DV/200.

1. Editing 3DV Sensor Data
↓
2. 2D Setup
↓
3. 3D Setup
↓
4. Parameter Setup
↓
5. Fixture Position Setup
↓
6. Mounting Position Setup
↓
7. Checking Mounting Position Setup Result

Setup flow of the 3DV Sensor data

2.1.1 Editing 3DV Sensor Data

Open the 3DV Sensor Data edit screen.
This system has pre-installed sample 3DV Sensor Data. The following explains the procedure for editing the settings based on that sample.

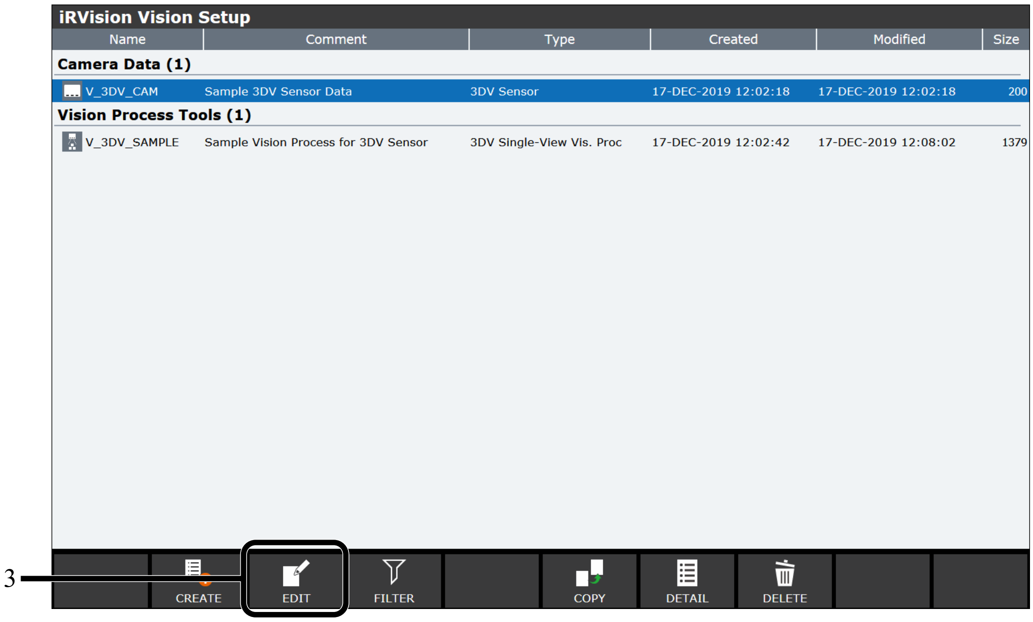
1 Place the calibration grid within the 3DV Sensor’s field of view.

⚠ **CAUTION**

The robot moves during automatic measurement of the calibration grid position. Do not place the calibration grid too close to the robot. Basically, place the calibration grid on the offset plane.

2 Select “V_3DV_CAM” in the [Camera Data] category on the vision data list screen.

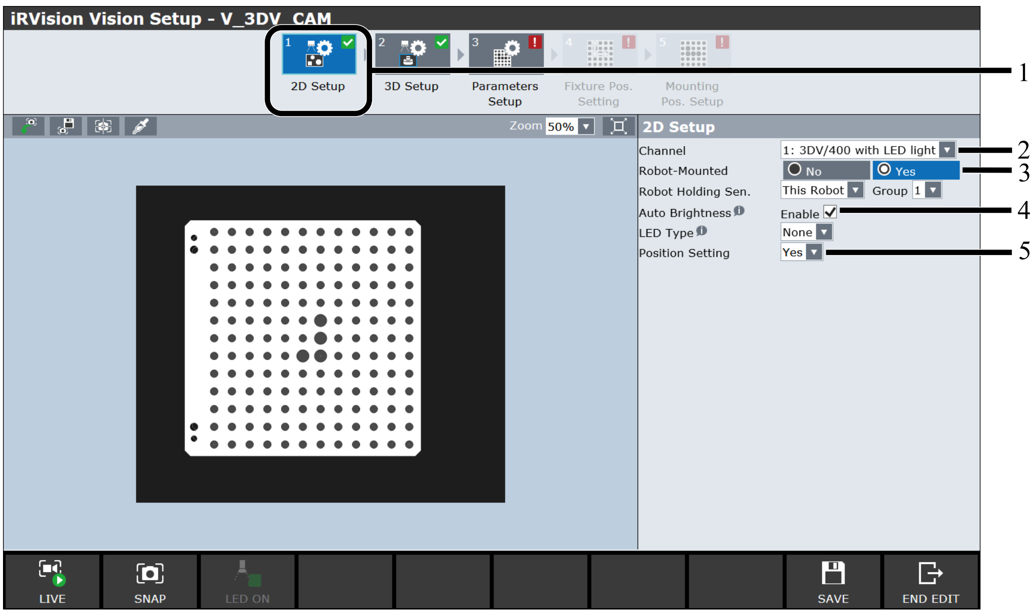
3 Click [EDIT].
The camera data edit screen appears.



2.1.2 2D Setup

Set up the conditions for snapping 2D images.

1 Click [1 2D Setup] in the navigation area.
The following screen appears.



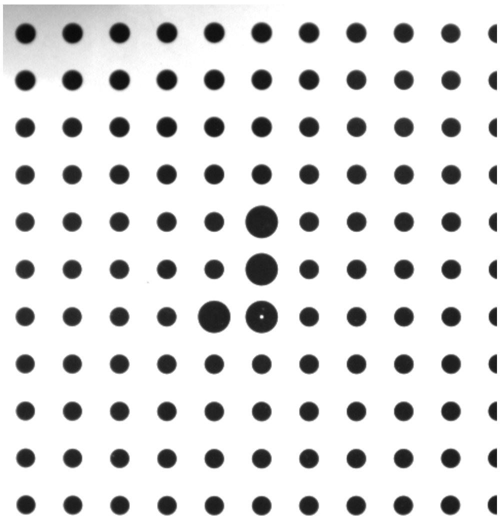
2 Select a camera from the [Channel] drop-down box.
When the 3DV Sensor to be used is selected, the 3DV Sensor automatically snaps an image, and the image appears in the image view area.

3 Select the 3DV Sensor mounting method.
If the 3DV Sensor is attached to the robot end of arm tooling, select [Yes] for [Robot-Mounted].

4 Check [Enable] for [Auto Brightness].
The 3DV Sensor can use the HDR function to automatically adjust the snap brightness. For details

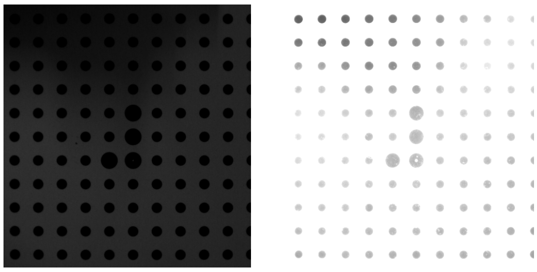
such as precautions for automatic adjustment, refer to the description of automatic brightness adjustment in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN".

If the calibration grid appears on the image display view as shown below, detection of the calibration grid and calibration will be performed normally.



Example of an appropriate image

If the calibration grid appears on the image display view as shown below, there will be a problem in detection of the calibration grid and calibration.



Too dark **Too light**

Examples of inappropriate images

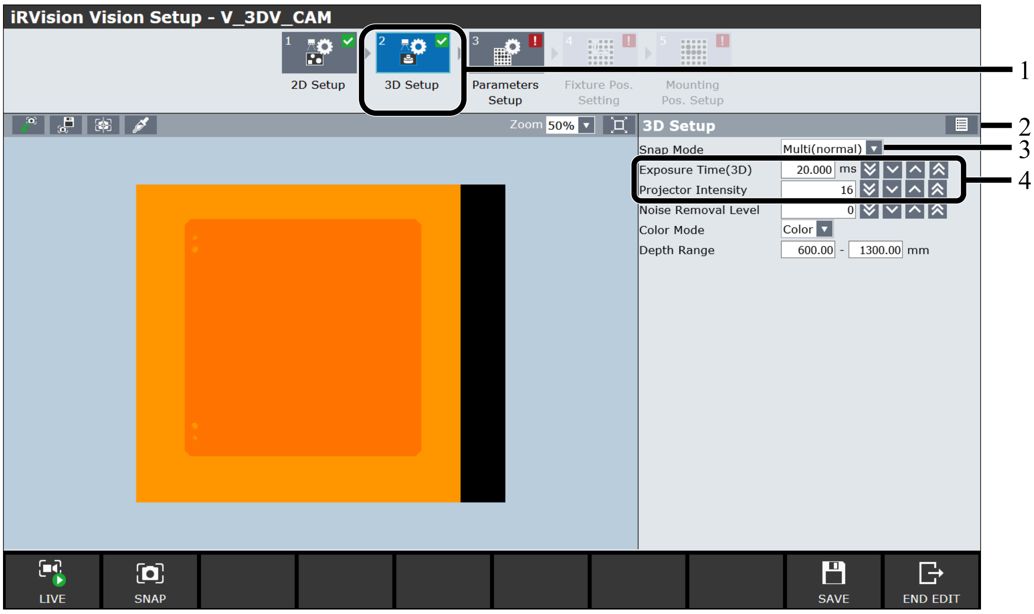
> ✐**Memo**
> If a well exposed image like the one above is not obtained using the automatic brightness adjustment of the HDR function, uncheck [Enable] for [Auto Brightness], and then adjust the exposure time in [Exposure Time (2D)] that is displayed. Adjust until the dots of the calibration grid are clearly visible. If the image is too dark, increase the exposure time (make the value bigger). On the other hand, if the image is too light, decrease the exposure time (make the value smaller). Each time you change the exposure time, an image snapped with the changed exposure time is displayed.

5 Select [Yes] for the [Position Setting] drop-down box.

2.1.3 3D Setup

Set up the conditions for snapping depth images.

1 Click [2 3D Setup] in the navigation area.
The following screen appears.



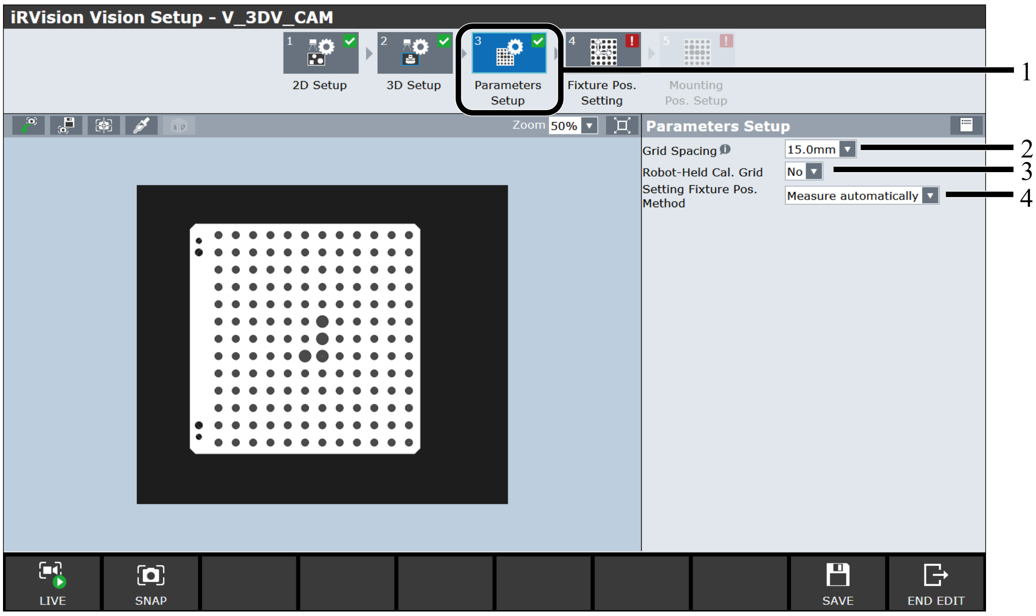
2 Click [icon] to switch to the advanced mode.
3 Set [Multi(normal)] from the [Snap Mode] drop-down box.
4 Adjust values of [Exposure Time (3D)] and [Projector Intensity] so that the depth data cannot be measured (the area displayed in black) decreases.

Memo
Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to the description of 3DV sensor in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.1.4 Parameter Setup

Set the grid spacing of the calibration grid and placement information.

1 Click [3 Parameters Setup] in the navigation area.
The screen to make settings such as the grid spacing of the calibration grid appears.



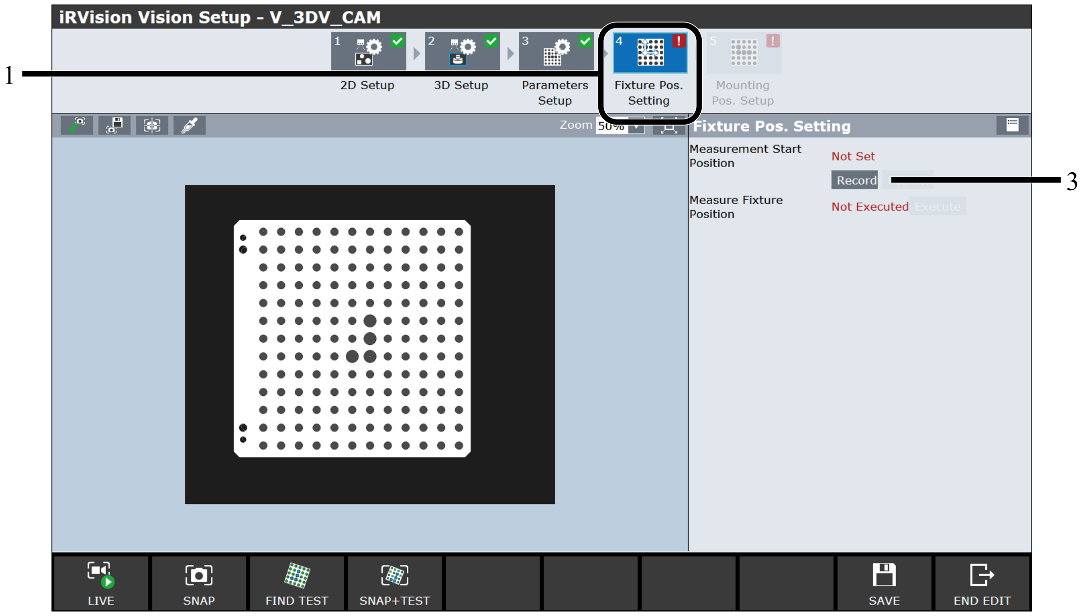
2 From the [Grid Spacing] drop-down box, select the grid spacing for the calibration grid.
3 Select [No] from the [Robot-Held Cal. Grid] drop-down box.
4 Select [Measure automatically] from the [Setting Fixture Pos. Method] drop-down box.

2

2.1.5 Fixture Position Setup

Automatically measure and set the calibration grid.
For details, refer to "Know-How: 1.2.1 Setting Procedure Using Camera Data Edit Screen."

1 Click [4 Fixture Pos. Setting] in the navigation area.
The calibration grid position setting screen will appear.



2 Jog the robot to the start position for automatic measurement.
Set the distance at which the center of the sensor faces that of the calibration grid almost directly as the measurement start position.
3 Click the [Record] button in [Measurement Start Position].
[Set] appears in [Measurement Start Position].
4 While holding down the [SHIFT] key on the teach pendant, click the [Excute] button in [Measure Fixture Position].
When the measurement is successfully completed, a message on successful completion is displayed in a pop-up window.
5 Check if there is a problem with the position information displayed in [Position of Cal. Grid Relative to App. UFrame].

⚠ CAUTION
From this point forward, do not move the calibration grid until the mounting position setup is complete.

2.1.6 Mounting Position Setup

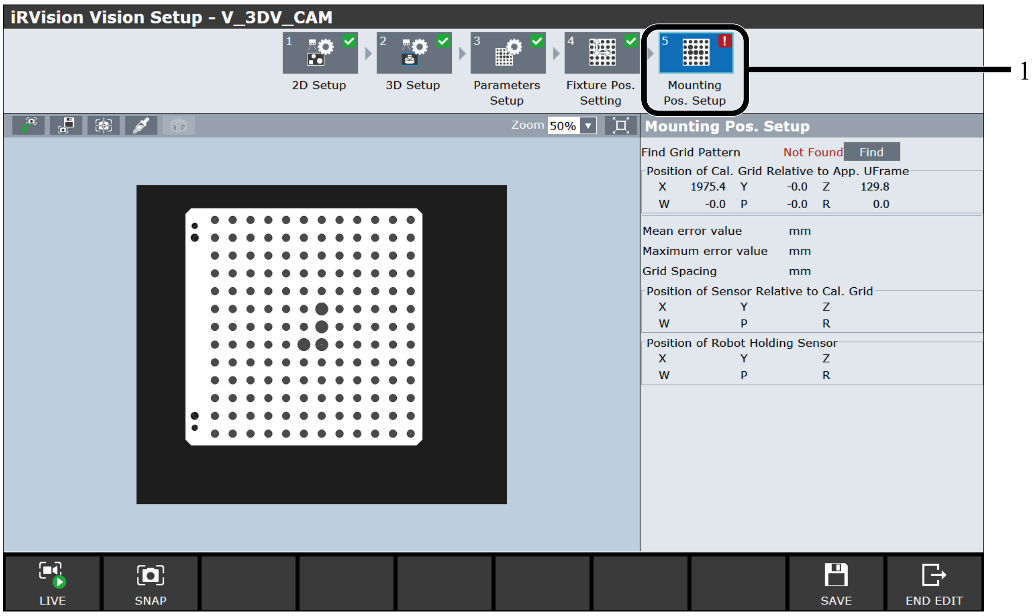
Detect the calibration grid and measure the 3DV Sensor mounting position.

When using the robot-mounted camera, after 3DV Sensor Data is created with the mounting position setup, another 3DV Sensor Data does not need to be created even if the camera measurement position is changed. This is because *i*RVision uses the current robot position when calculating the position of the part.

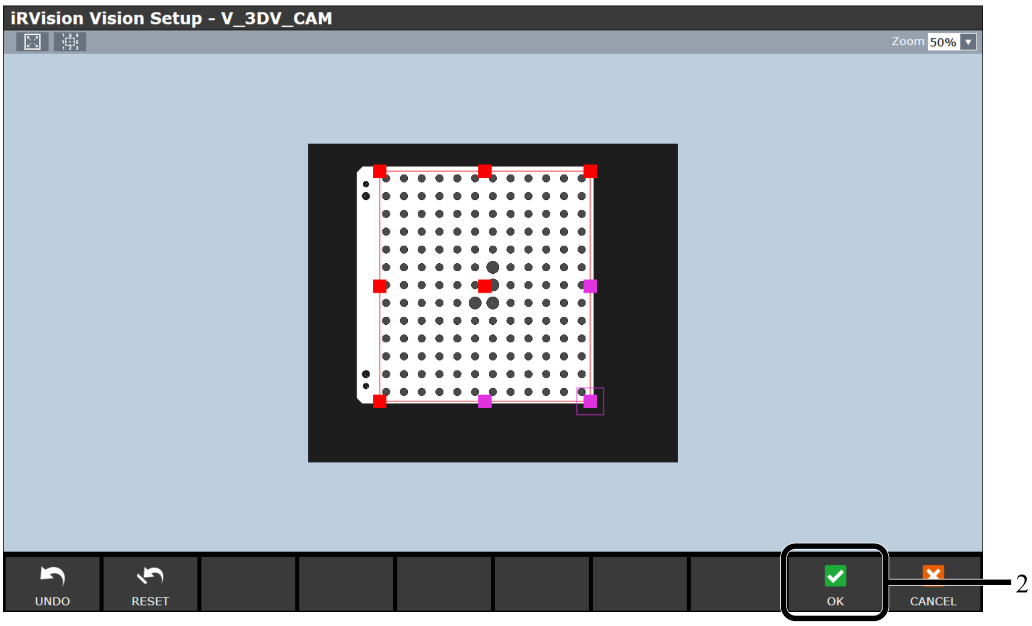
Mounting position setup procedure

The mounting position setup procedure is as follows.

1 Click [5 Mounting Pos. Setup] in the navigation area.
The mounting position setup screen appears.



2 Click the [Find] button in [Find Grid Pattern].
The following screen appears.

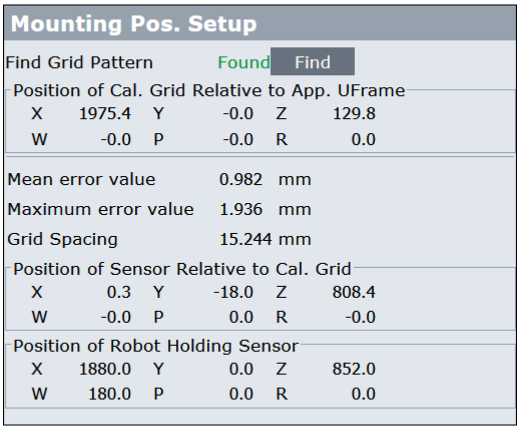


3 Teach the search window to enclose only the perfect circles on the calibration grid.
When the area outside the calibration grid is included in the search range, a circle detection error may occur. Therefore, teach the search window to enclose only the calibration grid. Also, if the grid pattern does not fit in the camera FOV, do not allow imperfect circles around the circumference of the camera FOV to be included within the search range.

4 Click [OK].
Check that all circles are detected in the snap view area. If the detection is successful, [Find Grid Pattern] shows [Found].

2.1.7 Checking Mounting Position Setup Result

Check the calculated mounting position setup result.



1 Check the calculated mounting position.

- Check that [Mean error value] is 1.0 mm or less.
- Check that [Maximum error value] is 3.0 mm or less.
- Check that the value of [Grid Spacing] is close to the value of the selected [Grid Spacing].
- Check that there is no red crosshair (+) on the image display view.

If the values etc. is not appropriate, perform the mounting position setup again.

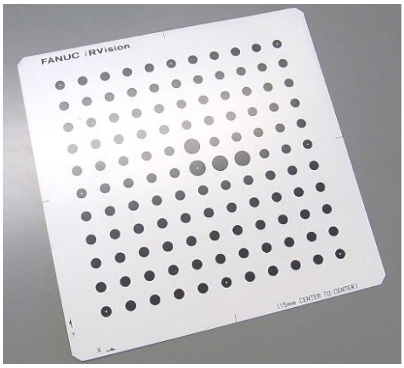
Memo

1 In case of 3DV/70 or 3DV/200, on the image display view, the grids with an error of more 0.5 mm are displayed in yellow crosshairs (+). The grids with an error of more 1 mm are displayed in red crosshairs (+).
2 In case of 3DV/400, 3DV/600 or 3DV/1600, on the image display view, the grids with an error of more 1 mm are displayed in yellow crosshairs (+). The grids with an error of more 3 mm are displayed in red crosshairs (+).

2 Click [SAVE] to save the setting, and then click [END EDIT] to close the 3DV Sensor Data edit screen.

2.2 3DV SENSOR MOUNTING POSITION SETUP WITH FIXED CAMERA

To use the 3DV Sensor, mounting position setup using a calibration grid is required. When performing mounting position setup, prepare a calibration grid in advance. You would usually use a calibration grid that is bigger than the field of view. A standard calibration grid is available from FANUC in several sizes. It is strongly recommended that you order a calibration grid as well as a camera and a lens.



Calibration grid

It is not necessary to detect all the circles on the calibration grid. There are 11 x 11 circles in the standard calibration grid of FANUC. If 7 x 7 circles can be detected, calibration is performed with high accuracy (the four large circles need to be detected). There is no need to prepare a small calibration grid in order to show all the circles in the field of view. In order to perform calibration with sufficient accuracy to the edge of the field of view, even if there are fewer detectable circles, prepare a calibration grid that is bigger than the field of view.
Use the following setup procedure for 3DV Sensor mounting position setup with a fixed camera.

> ⚠ **CAUTION**
> 1 30 mm calibration grid spacing is recommended when using 3DV/1600.
> 2 7.5 mm calibration grid spacing is recommended when using 3DV/70 or 3DV/200.

1. Editing 3DV Sensor Data

↓

2. 2D Setup

↓

3. 3D Setup

↓

4. Parameter Setup

↓

5. Fixture Position Setup

↓

6. Mounting Position Setup

↓

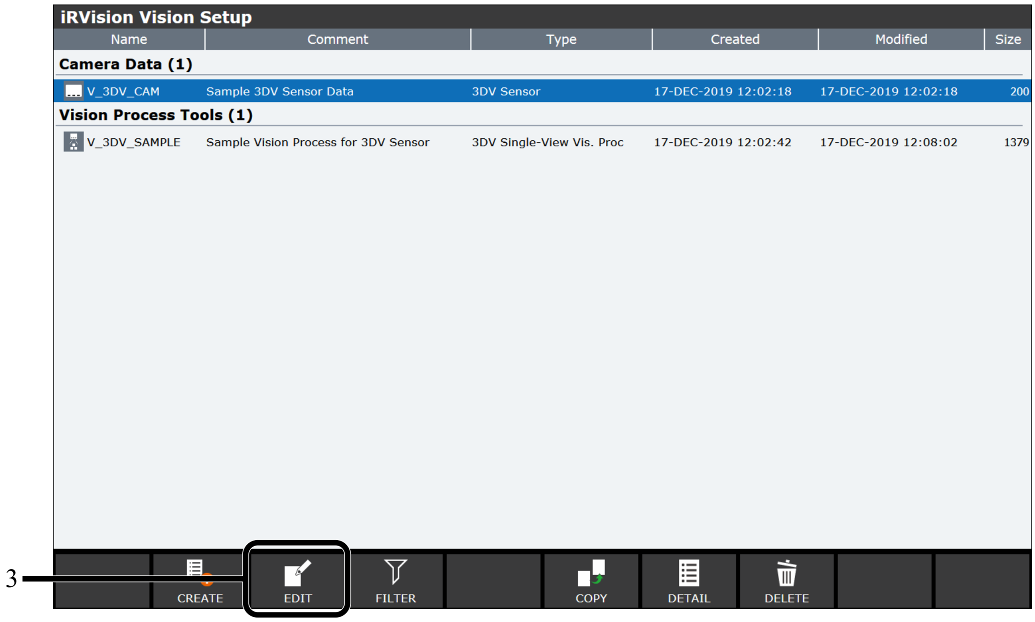
7. Checking Mounting Position Setup Result

Setup flow of the 3DV Sensor data

2.2.1 Editing 3DV Sensor Data

Open the 3DV Sensor Data edit screen.
This system has pre-installed sample 3DV Sensor Data. The following explains the procedure for editing the settings based on that sample.

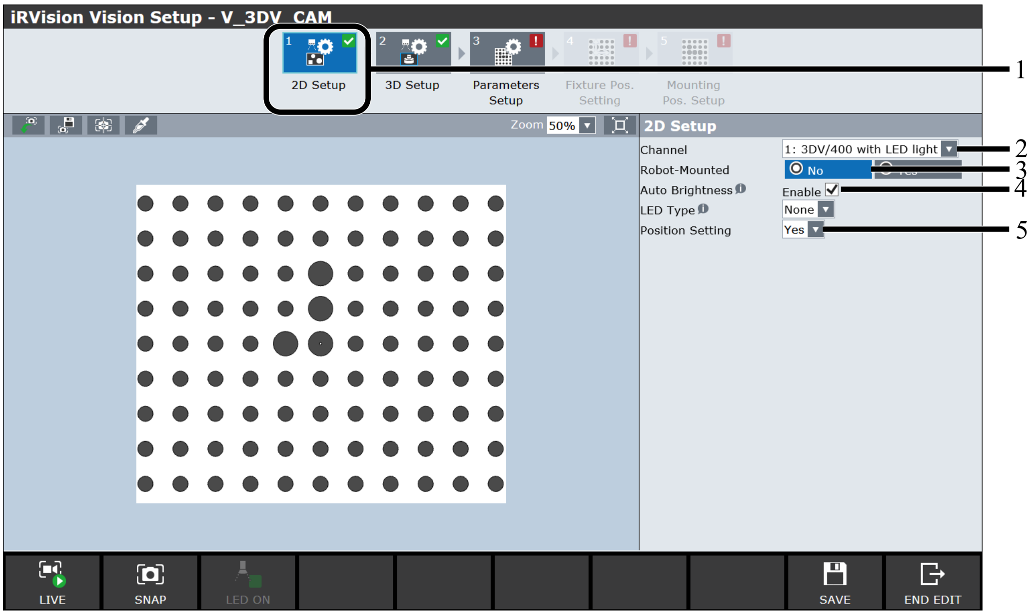
1 Place the calibration grid so that it faces the 3DV Sensor at a distance of about 800 mm within the 3DV Sensor's field of view.
2 Select "V_3DV_CAM" in the [Camera Data] category on the vision data list screen.
3 Click [EDIT].
The camera data edit screen appears.



2.2.2 2D Setup

Set up the conditions for snapping 2D images.

1 Click [1 2D Setup] in the navigation area.
The following screen appears.

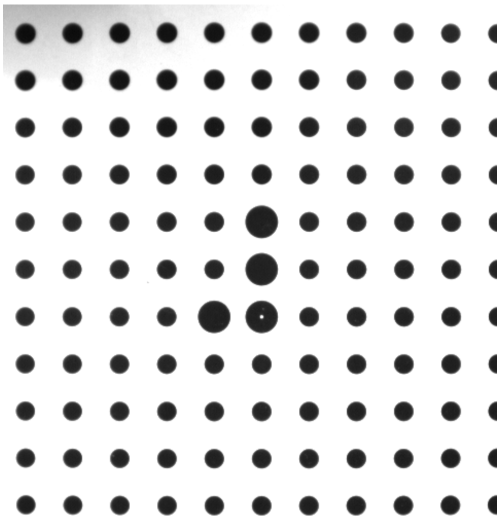


2 Select a camera from the [Channel] drop-down box.
When the 3DV Sensor to be used is selected, the 3DV Sensor automatically snaps an image, and the image appears in the image view area.

3 Select the 3DV Sensor mounting method.
If the 3DV Sensor is fixed, select [No] for [Robot-Mounted].

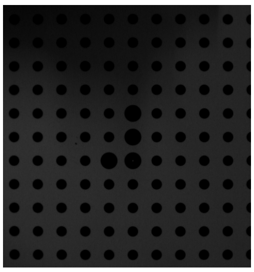
4 Check [Enable] for [Auto Brightness].
The 3DV Sensor can use the HDR function to automatically adjust the snap brightness. For details such as precautions for automatic adjustment, refer to the description of automatic brightness adjustment in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN".

If the calibration grid appears on the image display view as shown below, detection of the calibration grid and calibration will be performed normally.

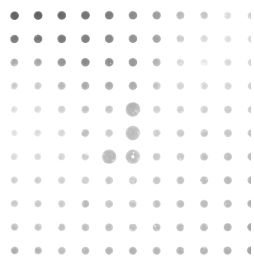


Example of an appropriate image

If the calibration grid appears on the image display view as shown below, there will be a problem in detection of the calibration grid and calibration.



Too dark



Too light

Examples of inappropriate images

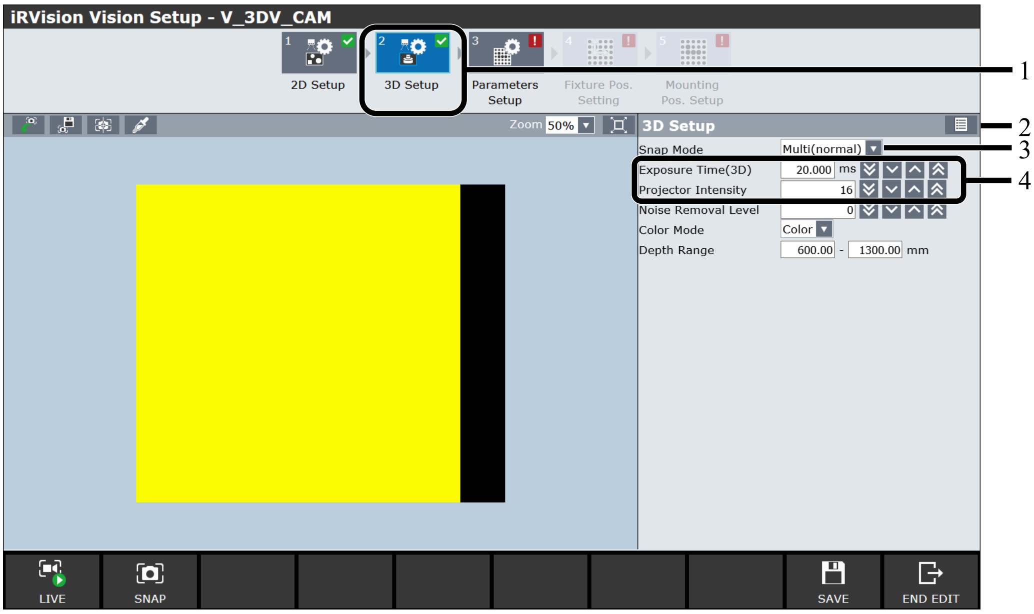
> **Memo**
> If a well exposed image like the one above is not obtained using the automatic brightness adjustment of the HDR function, uncheck [Enable] for [Auto Brightness], and then adjust the exposure time in [Exposure Time (2D)] that is displayed. Adjust until the dots of the calibration grid are clearly visible. If the image is too dark, increase the exposure time (make the value bigger). On the other hand, if the image is too light, decrease the exposure time (make the value smaller). Each time you change the exposure time, an image snapped with the changed exposure time is displayed.

5 Select [Yes] for the [Position Setting] drop-down box.

2.2.3 3D Setup

Set up the conditions for snapping depth images.

1 Click [2 3D Setup] in the navigation area.
The following screen appears.



2 Click  to switch to the advanced mode.
3 Set [Multi(normal)] from the [Snap Mode] drop-down box.
4 Adjust values of [Exposure Time (3D)] and [Projector Intensity] so that the depth data cannot be measured (the area displayed in black) decreases.

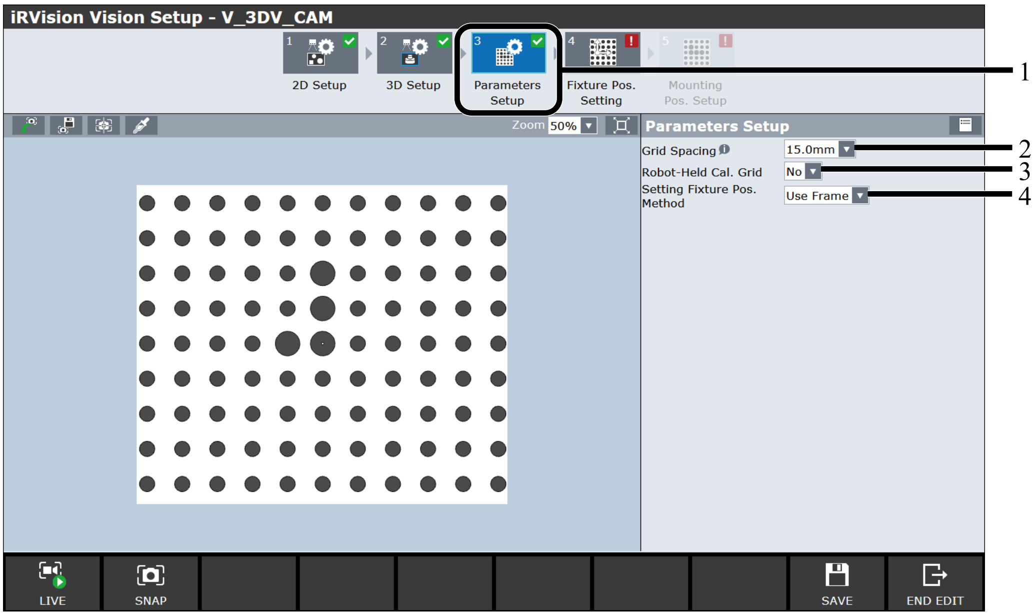
Memo

Because of its structure, the 3DV Sensor cannot measure the depth at the right edge of the sensor's field of view. For this reason, the right edge of the sensor's field of view may remain a black area. For details, refer to the description of 3DV sensor in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

2.2.4 Parameter Setup

Set the grid spacing of the calibration grid and placement information.

1 Click [3 Parameters Setup] in the navigation area.
The screen to make settings such as the grid spacing of the calibration grid appears.



2 From the [Grid Spacing] drop-down box, select the grid spacing for the calibration grid.
3 Select [No] from the [Robot-Held Cal. Grid] drop-down box.
4 Select [Use Frame] from the [Setting Fixture Pos. Method] drop-down box.

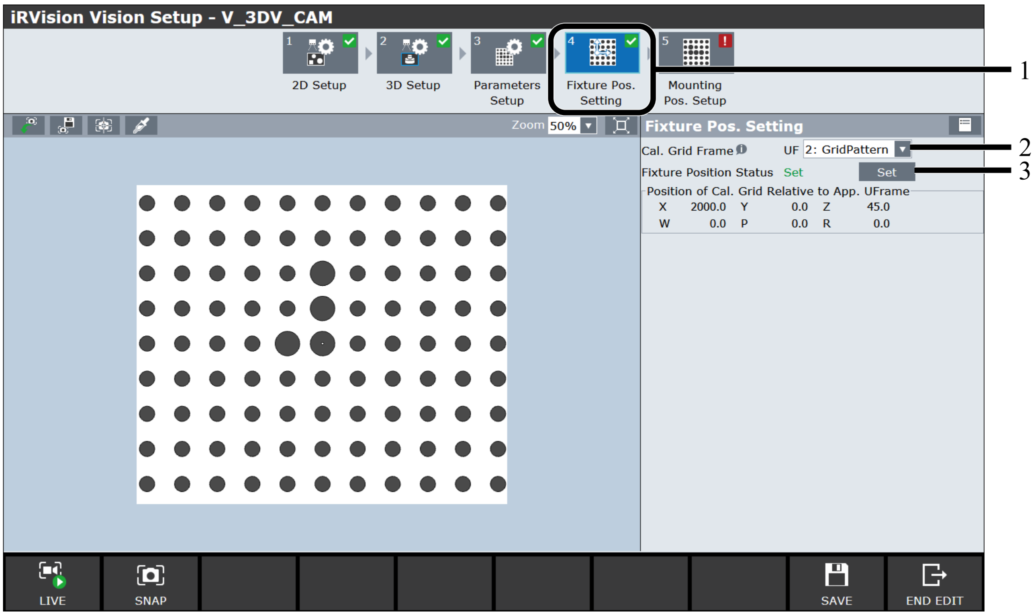
Memo

When the calibration grid is mounted to the gripper, select [Yes] from the [Robot-Held Cal. Grid] drop-down box. In this case, if you select [Measure automatically] from the [Measure Fixtures Position] drop-down box, the settings of the calibration grid can be measured automatically. For details, refer to “Know-How: 1.2.1 Frame Setting With Grid Frame Setting Function.”
When the calibration grid is fixed, automatic measurement is not available. In this section, it is assumed that the calibration grid is fixed.

2.2.5 Fixture Position Setup

Set the calibration grid position to camera data.

1 Click [4 Fixture Pos. Setting] in the navigation area.
The calibration grid position setting screen will appear.



2 From the [Cal. Grid Frame] drop-down box, select the number of the user frame in which the calibration grid installation information was recorded.
In order to set up the user frame for the calibration grid, refer to "Know-How: 1.2 FRAME SETTING WITH GRID FRAME SETTING FUNCTION."

> ⚠ **CAUTION**
> From this point forward, do not move the calibration grid until the mounting position setup is complete.

> **Memo**
> Note that the frame for installation information of the calibration grid is different from [Application Frame] and [Offset Frame].

3 Click the [Set] button of [Fixture Position Status].

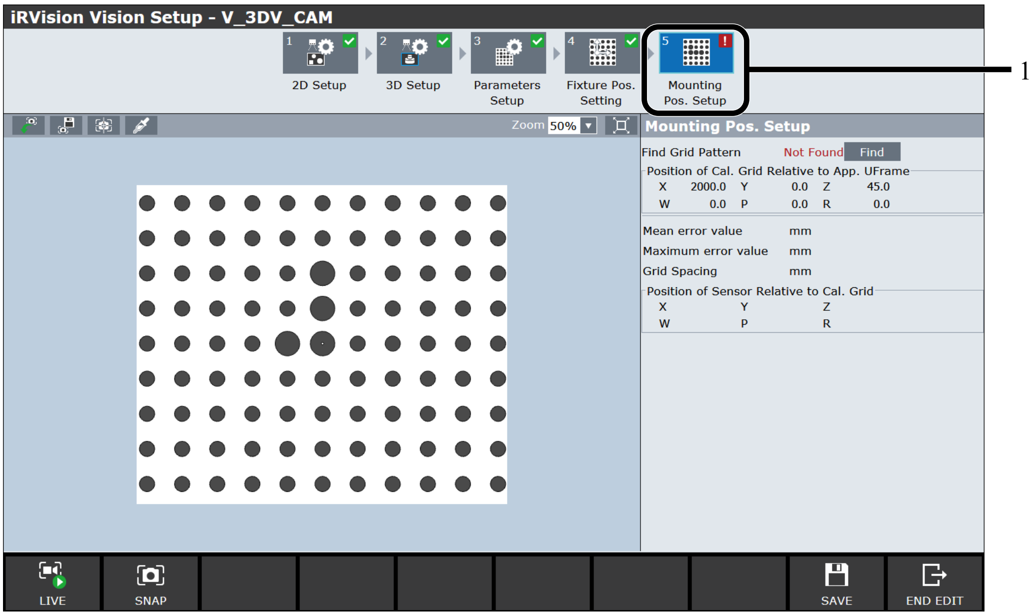
2.2.6 Mounting Position Setup

Detect the calibration grid and measure the 3DV Sensor mounting position.

Mounting position setup procedure

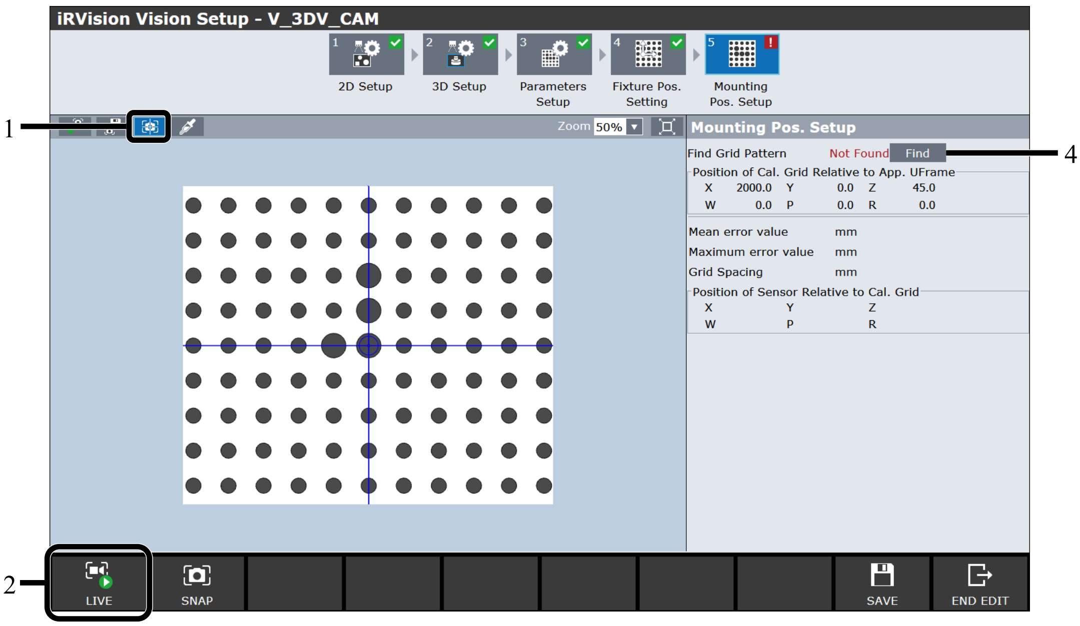
The mounting position setup procedure is as follows.

1 Select [5 Mounting Pos. Setup] in the navigation area.
The mounting position setup screen appears.



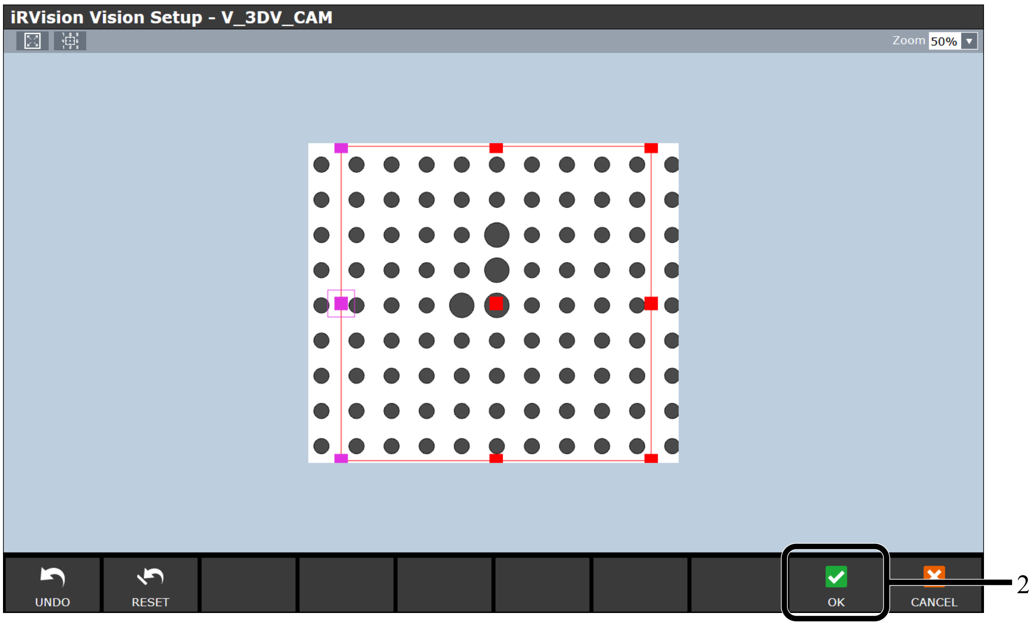
Moving the calibration grid to an appropriate position

When the setting of 3DV Sensor described so far is completed, move the calibration grid to an appropriate position by following the steps below to perform mounting position setup.



1 Click the button.
A vertical line and a horizontal line appear in the image view area to indicate the center of the image. Based on these lines, the calibration grid can be aligned with the center of the image.
2 Click [LIVE].
The live image of the selected camera appears in the image view area.
3 Move the calibration grid so that the center of the calibration grid is almost at the center of the image view area.
The bottom surface of the camera of the 3DV Sensor faces the calibration grid almost straight with a distance of about 800 mm. Jog the robot in the XY direction of the calibration grid so that the center of the calibration grid is almost at the center of the image view area. Next, move the calibration grid so that the center of the calibration grid is almost at the center of the image view area.
4 Click the [Find] button in [Find Grid Pattern].

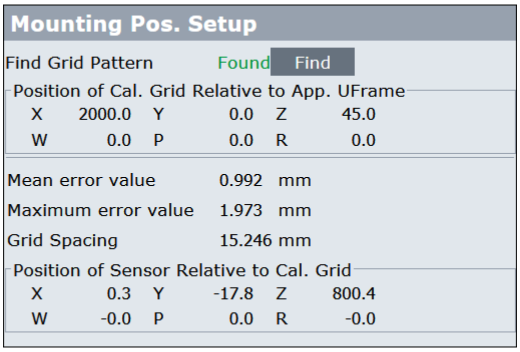
Executing the mounting position setup



1 Teach the search window to enclose only the perfect circles on the calibration grid.
When the area outside the calibration grid is included in the search range, a circle detection error may occur. Therefore, teach the search window to enclose only the calibration grid. Also, if the grid pattern does not fit in the camera FOV, do not allow imperfect circles around the circumference of the camera FOV to be included within the search range.
2 Click [OK].
Check that all circles are detected in the snap view area. If the detection is successful, [Find Grid Pattern] shows [Found].

2.2.7 Checking Mounting Position Setup Result

Check the calculated mounting position setup result.



1 Check the calculated mounting position.
- Check that [Mean error value] is 1.0 mm or less.
- Check that [Maximum error value] is 3.0 mm or less.
- Check that the value of [Grid Spacing] is close to the value of the selected [Grid Spacing].
- Check that there is no red crosshair (+) on the image display view.

If the values etc. are not appropriate, perform the mounting position setup again.

> **Memo**
> 1 In case of 3DV/70 or 3DV/200, on the image display view, the grids with an error of more 0.5 mm are displayed in yellow crosshairs (+). The grids with an error of more 1 mm are displayed in red crosshairs (+).
> 2 In case of 3DV/400, 3DV/600 or 3DV/1600, on the image display view, the grids with an error of more 1 mm are displayed in yellow crosshairs (+). The grids with an error of more 3 mm are displayed in red crosshairs (+).

2 Click [SAVE] to save the setting, and then click [END EDIT] to close the 3DV Sensor Data edit screen.

3 EXAMPLE OF SETTING ACCORDING TO USAGE

This chapter explains examples of settings according to usage of 3DV Sensor.

3.1 SENSOR

3.1.1 Improving Detection Performance

The accuracy of 3D points and 2D images measured by 3DV Sensor is higher the closer the standoff of the 3DV Sensor is to the focus position of the camera in the 3DV Sensor. Detection Performance may be improved by adjusting the layout so that the distance between the 3DV Sensor and the part is close to the focus position.
The focus position of the 3DV sensor is as follows.

- 3DV/70: 191mm
- 3DV/200: 395mm
- 3DV/400: 800mm
- 3DV/600: 1615mm
- 3DV/1600: 2240mm

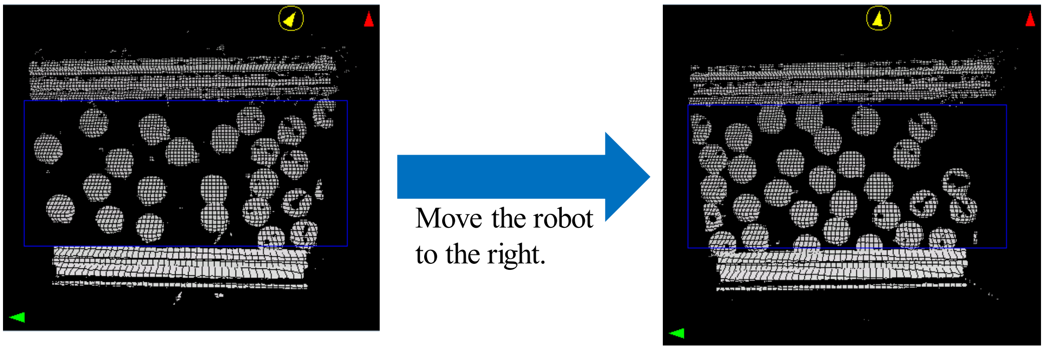
3.2 ROBOT-MOUNTED CAMERA

3.2.1 Moving Search Window of 3D Command Tool with Robot-Mounted Camera According to Robot's Snap Position

The search window of the 3D command tool is set on the frame used for detection. The frame used for detection is the camera frame when [Camera Base Find] is valid, and is the offset frame otherwise. If [Camera Base Find] is invalid with a robot-mounted camera and the search window of the 3D command tool is used, the search window may be out of the view area when the robot's snap position changes, and the part cannot be detected at all.
To move the search window of the 3D command tool according to the snap position of the robot, use [Camera Base Find].

The setting procedure of the example using the 3D Blob Locator Tool is explained below.

1. Create 3DV Single-View Vision Process and click the [Edit] button to open the setup screen.
2. Set [3DV Sensor] and [Offset Frame].
3. Switch to the advanced mode and check the checkbox of [Camera Base Find].
4. Select [3D Blob Locator Tool] in the tree view and set [Search Window].



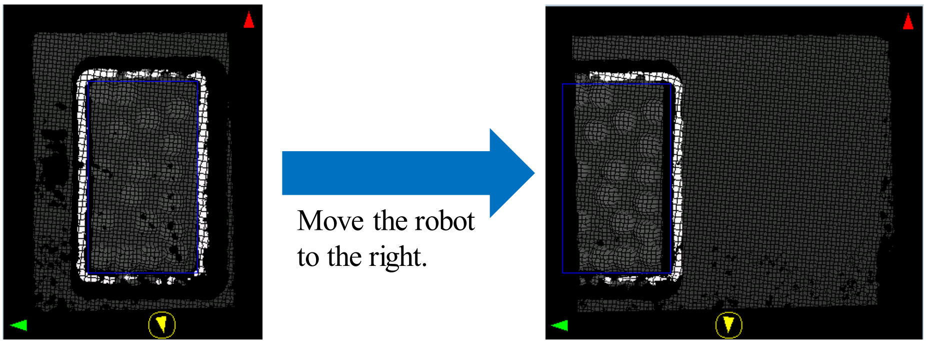
The search window moves according to the robot motion.

3.2.2 Fixing Search Window of 3D Command Tool with Robot-Mounted Camera Regardless of Robot's Snap Position

The search window of the 3D command tool is set on the frame used for detection. The frame used for detection is the camera frame when [Camera Base Find] is valid, and is the offset frame otherwise. When the area to be detected is fixed on the world frame, detection can be performed regardless of the snap position of the robot by disabling [Camera Base Find].

The setting procedure of the example using the 3D Blob Locator Tool is explained below.

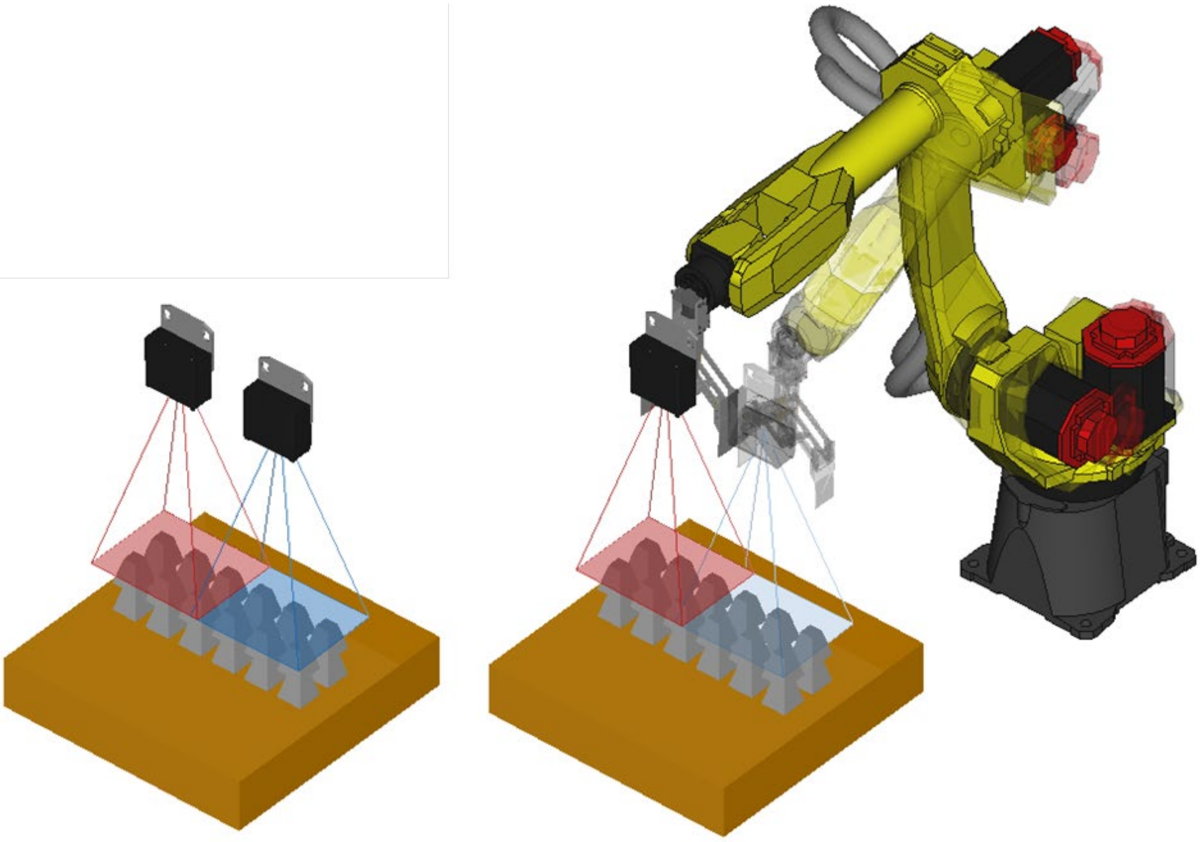
1 Create 3DV Single-View Vision Process and click the [Edit] button to open the setup screen.
2 Set [3DV Sensor] and [Offset Frame].
3 Switch to the advanced mode and uncheck the checkbox of [Camera Base Find].
4 Select [3D Blob Locator Tool] in the tree view and set [Search Window].



The search window is fixed to the container.

3.3 3DV SENSOR STITCHING

3DV Sensor stitching is a vision process that offsets the robot motion by integrating depth images measured by multiple 3DV Sensors or at multiple measurement positions and use them as a single depth image to detect position and posture of the part in 3D. With this vision process, 3D fixed offset and bin picking can be performed.



Although the system setup procedure is similar to that for the “3DV Single-View Vision Process”, it is necessary to configure the setting to obtain the snapped depth images from multiple camera views and to teach a command tool to integrate depth images. For details, refer to the description of 3DV Stitching Vision Process in “*i*RVision OPERATOR’S MANUAL (Reference) B-83914EN.”
This section explains how to perform 3D fixed offset for a large part by snapping multiple camera views with a single 3DV Sensor mounted to the robot as an example.

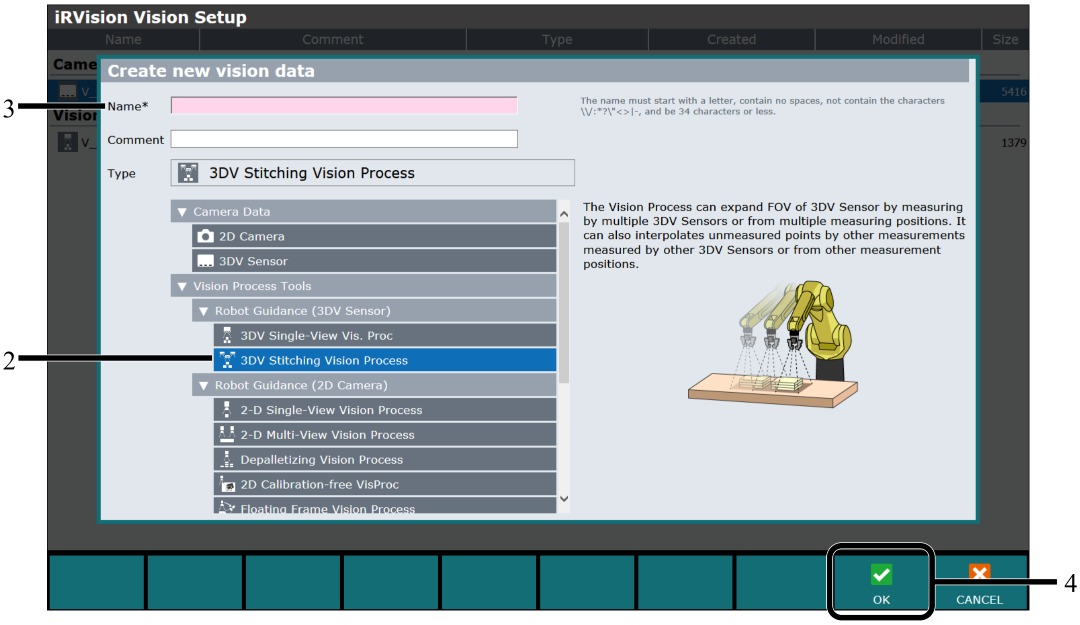
3.3.1 Setting up Vision Process

Create and set a “3DV Sensor Stitching” vision process.

3.3.1.1 Creating vision process

Create a vision process and open the edit screen.

1 Click [CREATE] on the vision data list screen.
2 Click the type of vision data to create.
Select [3DV Stitching Vision Process] in [Vision Process Tools].

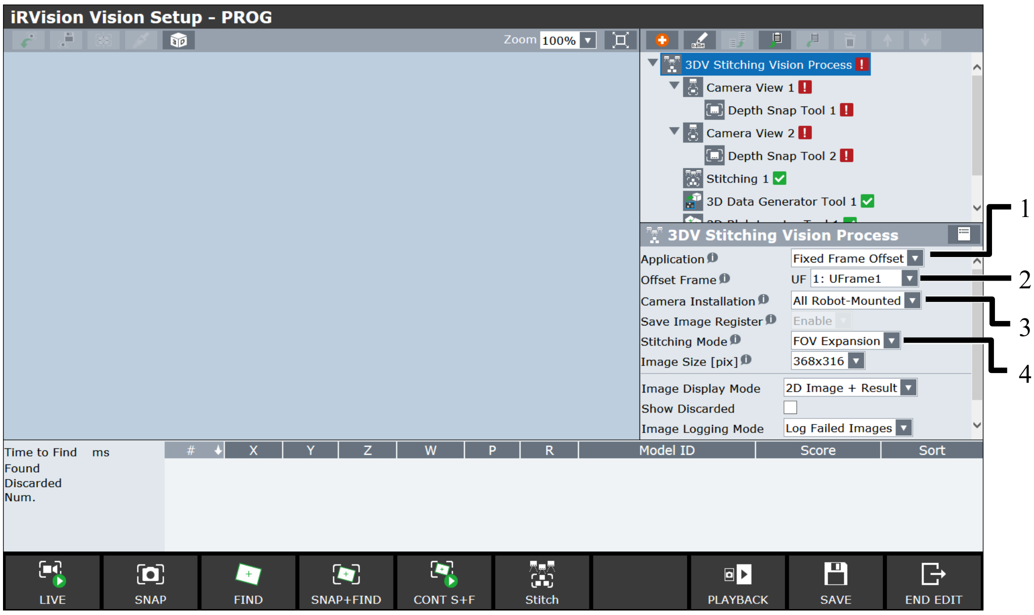


3 In [Name], enter the name of the vision process you are going to create.
The name can be up to 34 alphanumeric characters in length. The name must not contain spaces or symbols other than underscores, and must start with a letter.
In [Comment], enter any character string providing additional information about the vision data if necessary. The comment can be up to 50 one-byte or 25 two-byte characters.
4 Click [OK].
A new vision process is created.
5 When the screen returns to the vision data list screen, select the created vision process and click [Edit].

> ⚠ **CAUTION**
> The following names are not usable as the name of the vision data:
> CON, PRN, AUX, NUL, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9.

3

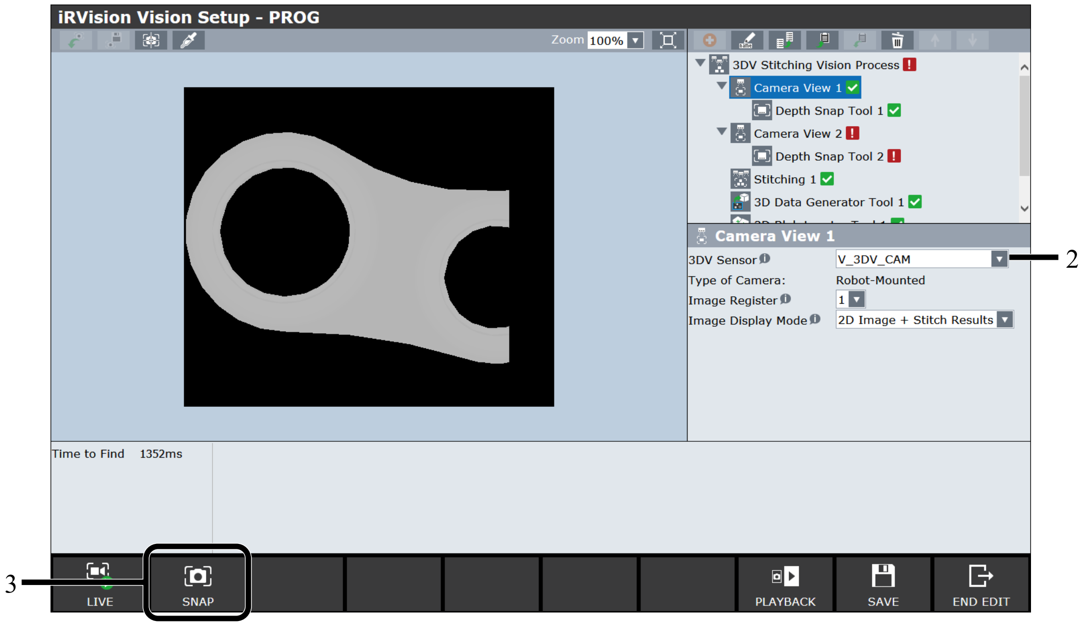
3.3.1.2 Setting parameters of vision process



1 Select [Fixed Frame Offset] from the [Application] drop-down box.
2 Set the user frame that you want to use as the base for offset calculation from the [Offset Frame] drop-down box.
3 Select [All Robot-Mounted] from the [Camera Installation] drop-down box.
4 Select [FOV Expansion] from the [Stitching Mode] drop-down box.

3.3.1.3 Camera View 1 setup

Select [Camera View 1] in the tree view, and then set each item.



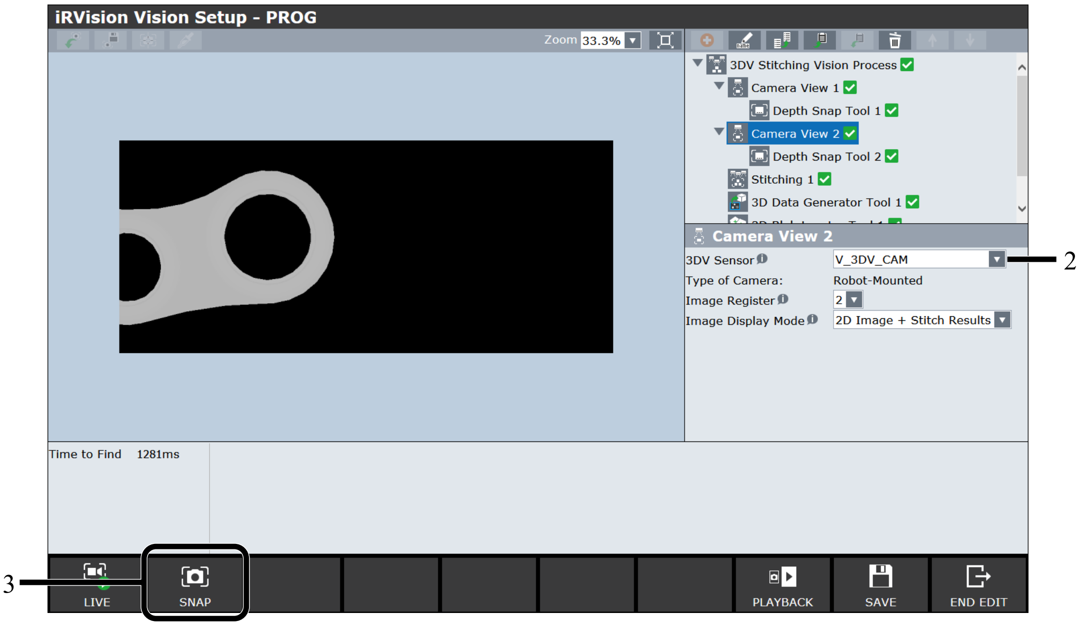
1 Jog the robot so that the field that you want to include in the first camera view is within the sensor's field of view.
2 Select the sensor data to use from the [3DV Sensor] drop-down box.
When sensor data is selected, a depth image is snapped.

> **Memo**
> In the setup example in this section, all the sensor data selected for the camera view must be that from a sensor mounted to the robot. Specifically, it is the sensor data for which [Yes] is selected for [Robot-Mounted].

3 To adjust the snapping position, jog the robot and click [SNAP] again.
At this point, there is only one snapped depth image and so only the depth image of camera view 1 is shown in the image display area.

3.3.1.4 Camera View 2 setup

Select [Camera View 2] in the tree view, and then set each item.



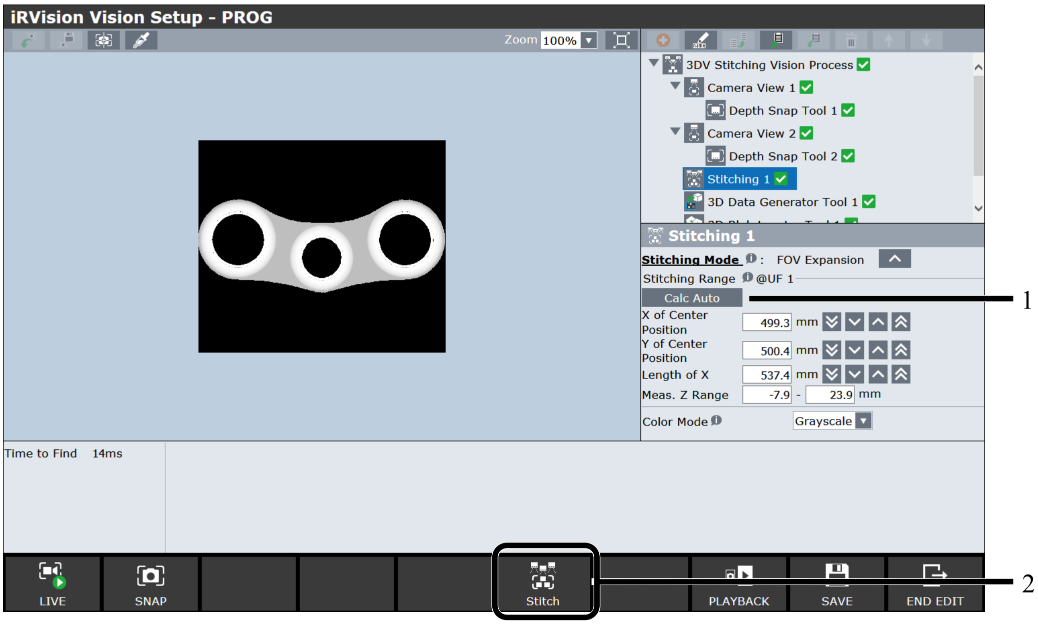
1 Jog the robot so that the field that you want to include in the second camera view is within the sensor's field of view.
2 Select the sensor data to use from the [3DV Sensor] drop-down box.

> **Memo**
> In the setup example in this section, all the sensor data selected for the camera view must be that from a sensor mounted to the robot. In the setup example in this section, since multiple camera views are snapped with a single 3DV Sensor, select the same sensor data used for Camera View 1.

3 To adjust the snapping position, jog the robot and click [SNAP] again.
The depth image snapped by camera view 2 is shown on the left of the image display area. Although a stitched image is shown on the right of the image display area, it will not be a correctly stitched image until the range of stitching, which is explained in the next section, has been set.

3.3.1.5 Setting Stitching

Select [Stitching 1] in the tree view, and then set each item.



1 Click [Calc Auto].
The stitching range in the green border section is automatically calculated.
When [FOV Expansion] is set for [Stitching Mode], a stitching range is calculated in a way the field of view of all camera views will be included.

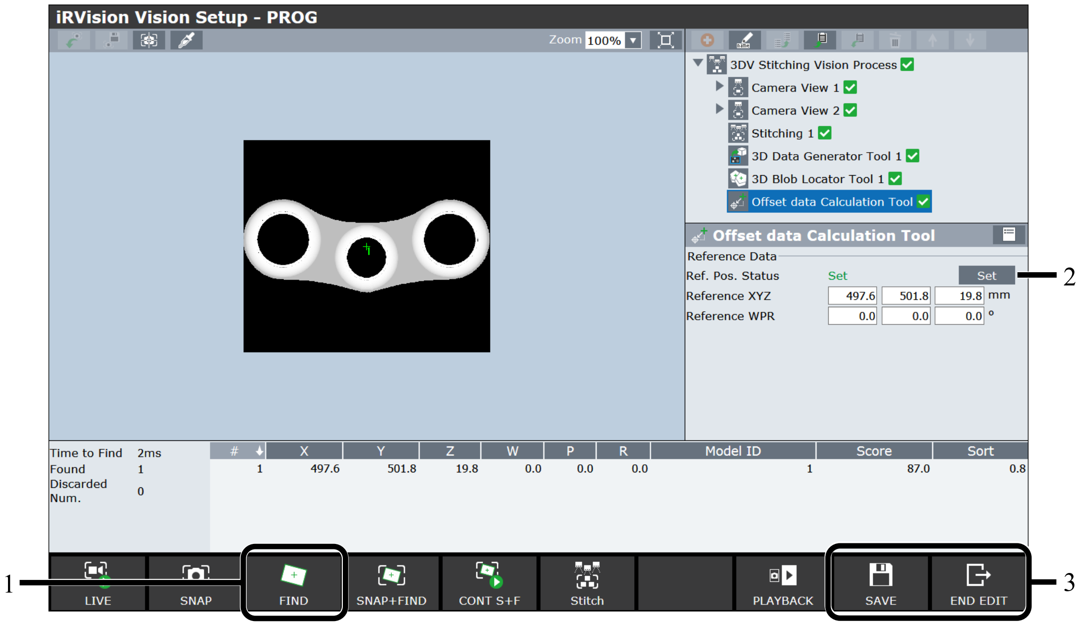
2 Click [Stitch].

> **Memo**
> When you click [SNAP] here, a depth image is snapped at the current robot gripper position and the snapped image is reflected to all camera views. In such a case, redo snapping with each camera view.

3 Check stitching results.
Adjust parameters as necessary.

3.3.1.6 Setting reference position

Here, place a part on a reference position, run a test and set the detection result as the reference position XYZWPR.
When the vision process is performed after the setting, the vision process calculates the offset data by comparing the actual position where the part is detected against the reference position.
Select [Offset data Calculation Tool] in the tree view, and then set each item.



1 Click [SNAP] to find the part.
2 Check that the part has been found correctly, and click the [Set] button of [Ref. Pos. Status].
3 Click [SAVE] and then [END EDIT].

> ⚠ **CAUTION**
> From this point forward, do not move the part until teaching of the robot motion when the part is placed at the reference position is finished in the TP program.

3.3.2 TP Program

The TP instruction, [VISION RUN_FIND] and KAREL programs, [IRVSNAP.KL] and [IRVFIND.KL] are not supported. Use KAREL processes, [IRVSTSNAP.KL] and [IRVSTRUNFIND.KL], instead.

1: ! Snap by Camera View1 and store snapped depth image
2: ! in the image register which is selected in the setup page.
3:
4: J PR[2:cameraview1] 60% FINE
5: CALL **IRVSTSNAP**("Vision Process"='Prog',
"Camera View"=1)
6:
7: ! Snap by Camera View2 and store snapped depth image
8: ! ! in the image register which is selected in the setup page.
9:
10: J PR[3:cameraview2] 60% FINE
11: CALL **IRVSTSNAP**("Vision Process"='Prog',
"Camera View"=2)
12:
13: ! Create an integrated depth image by stitching depth images by camera views and find parts.
14: CALL **IRVSTRUNFIND**("Vision Process"='Prog')

3.3.3 Other Applications

3DV Sensor installation

When the 3DV Sensor used for switching is fixed, select [All Robot-Mounted] from the [Camera Installation] drop-down box in the vision process. When 3DV Sensors mounted to the robot and fixed are used in combination, select [Both].

For a TP Program example in such a case, refer to the description of 3DV Stitching Vision Process in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Stitching in bin-picking

When using stitching, set interference avoidance data and Parts List Manager in the same way as with bin picking using a single 3DV Sensor.

Note, however, that instead of using the image registers on the SEARCH VP List edit screen, those set with camera views are used.

In a TP program, call the [BINPICK_SEARCH] macro program when finding, instead of using the [IRVSTRUNFIND.KL] macro program.

3.4 BIN PICKING

3.4.1 Setting Container Larger Than Field of View of 3DV Sensor

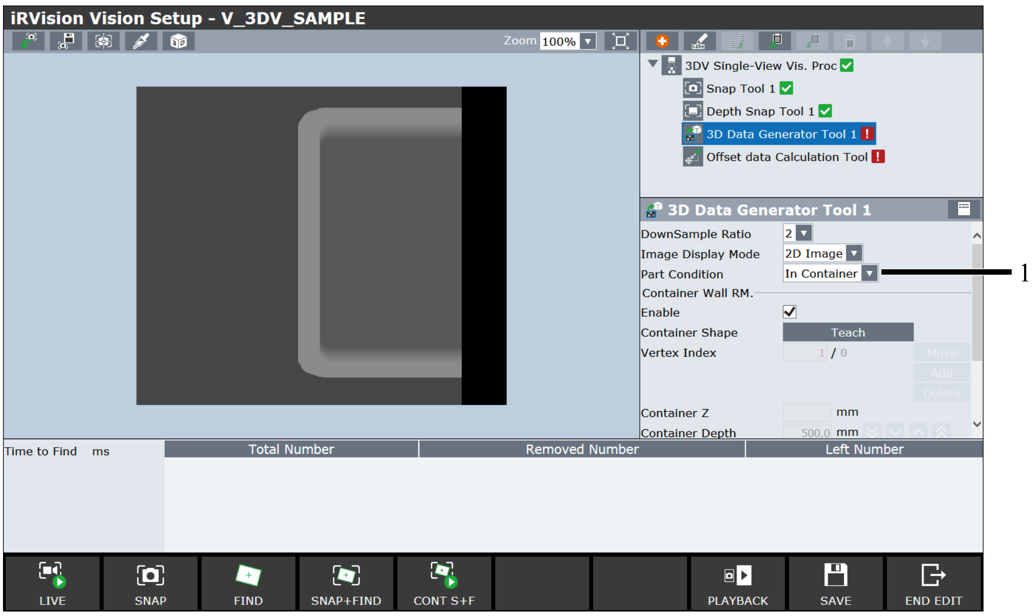
This section explains how to set [Container Shape] in the 3D Data Generator Tool when dealing with a container that cannot fit within the field of view of the 3DV Sensor.

Only if the following conditions are satisfied.

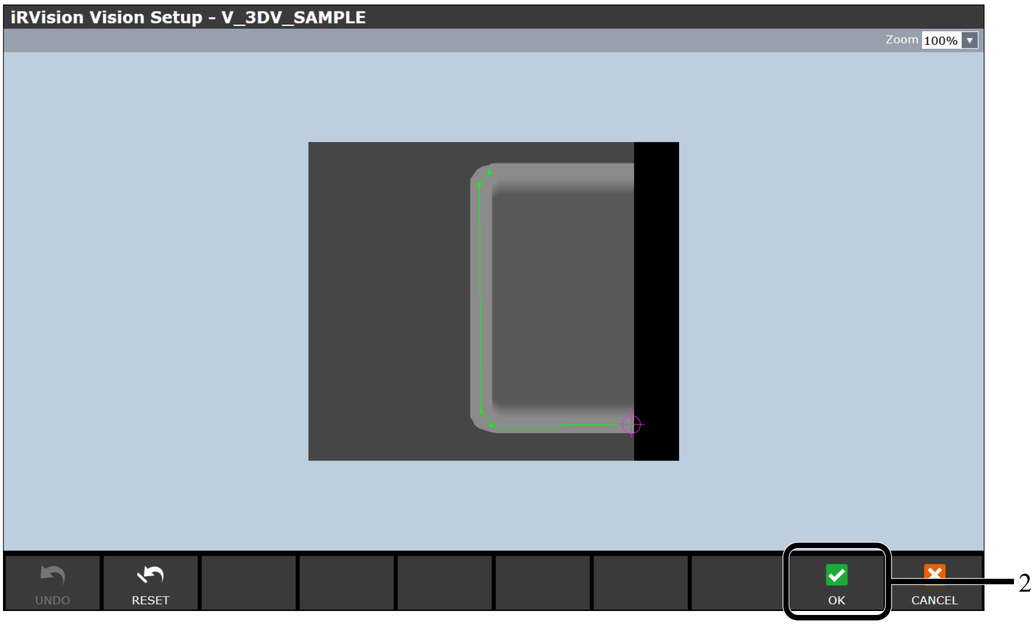
- The 3DV Sensor can be moved with the robot-mounted camera or using similar methods.
- [Camera Base Find] in [3DV Single-View Vis. Proc] is not checked.

The setting procedures are explained below.

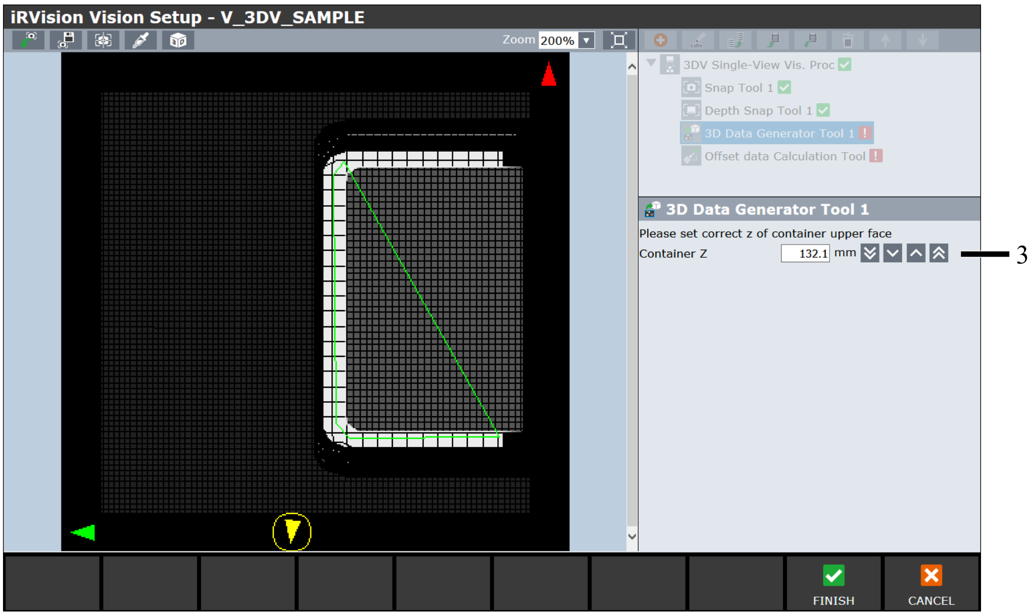
1 Open the vision process of '3DV Single-View Vis Proc' and select [In Container] from the [Part Condition] drop-down box in the setup screen of [3D Data Generator Tool].



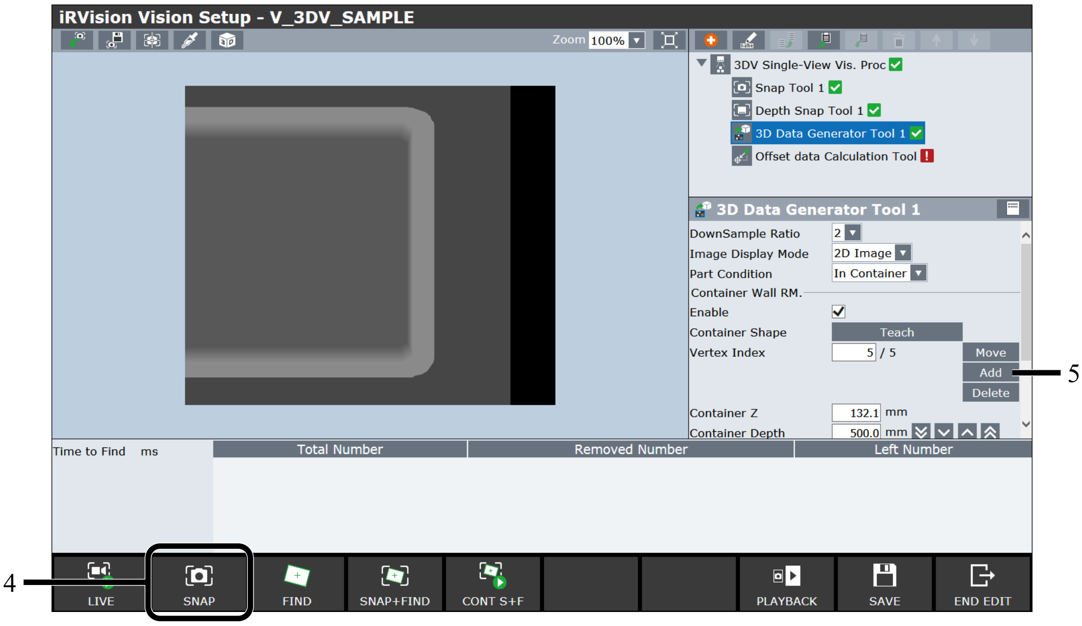
2 Click the [Teach] button, teach vertices (corners) at the edge of the visible area of the top of the container in order and click the [OK] button. In the figure below, 5 vertices are taught.



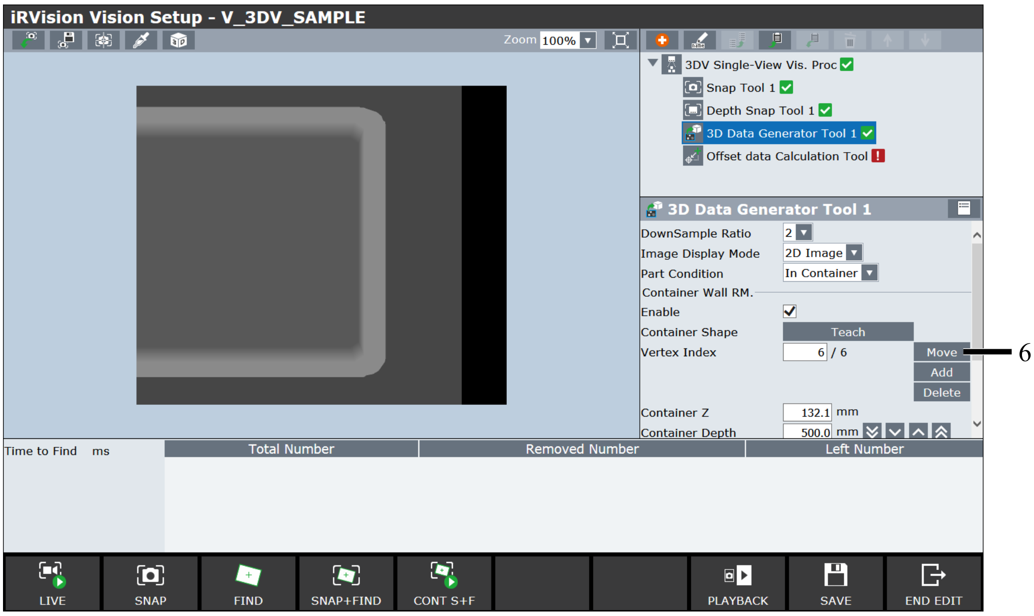
3 Set [Container Z] and click the [FINISH] button. [Container Z] will be adjusted later, so a rough value can be entered here.



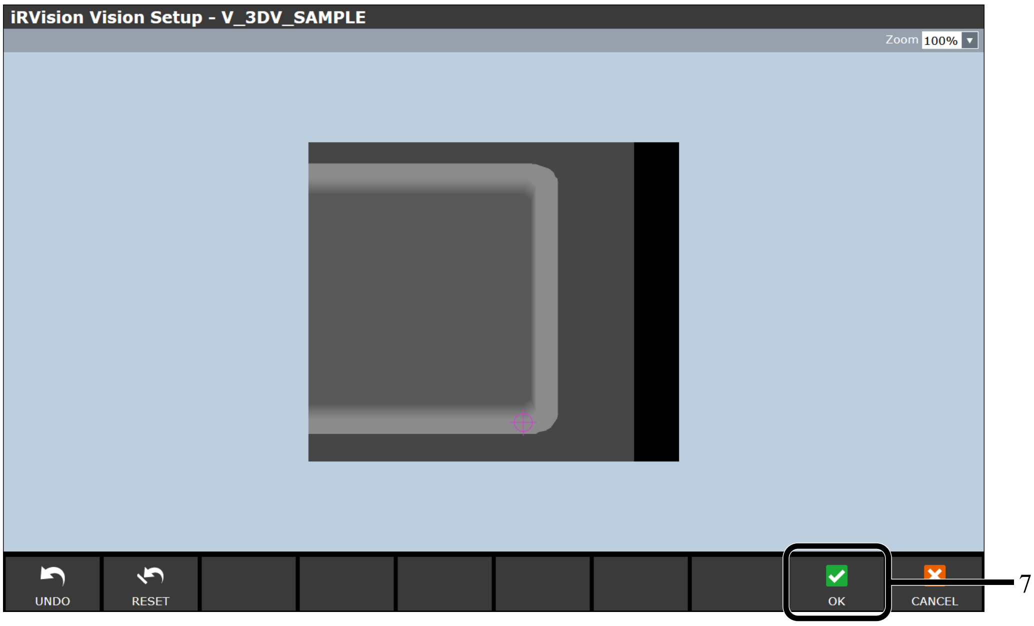
4 Move the 3DV Sensor so that the container area not shown in the snap can be seen and click the [SNAP] button.
5 Specify the last number of [Vertex Index] and click the [Add] button.



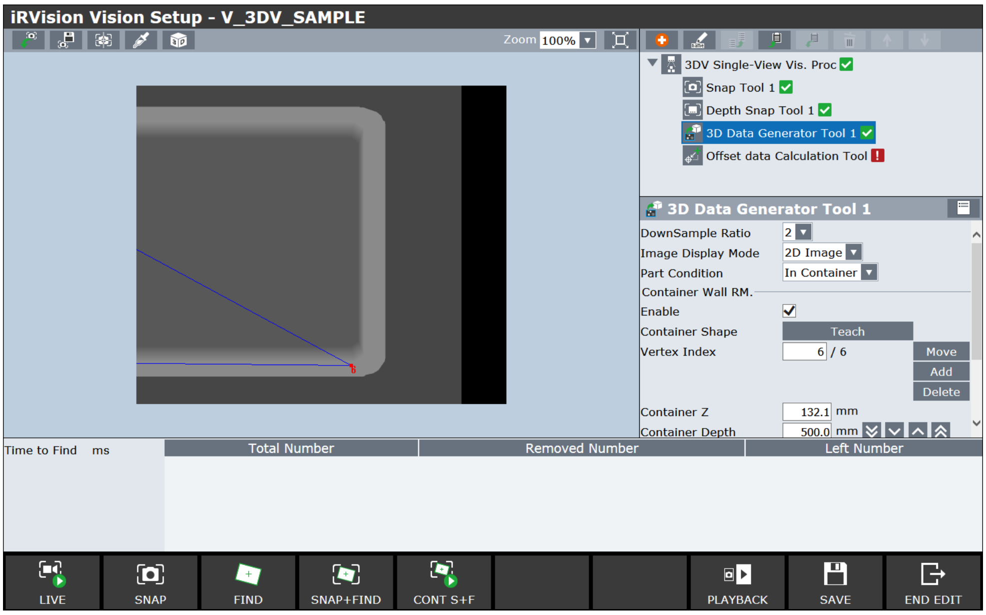
6 A vertex is added to [Vertex Index]. Specify the number of the added [Vertex Index] and click the [Move] button.



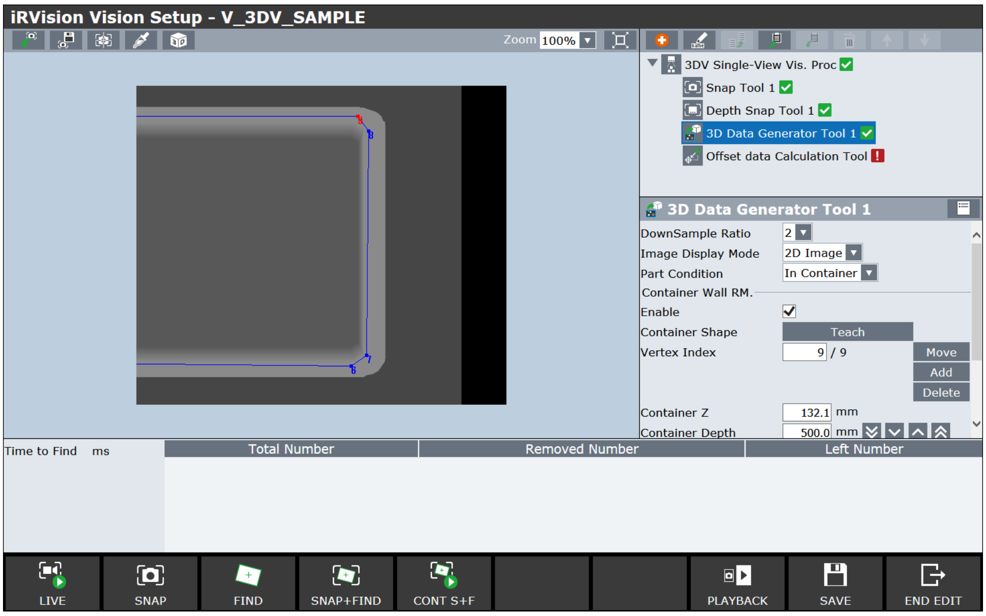
7 Move ⊕ to any vertex at the edge of the top of the container and click the [OK] button.



8 A new [Vertex Index] is set as shown below.

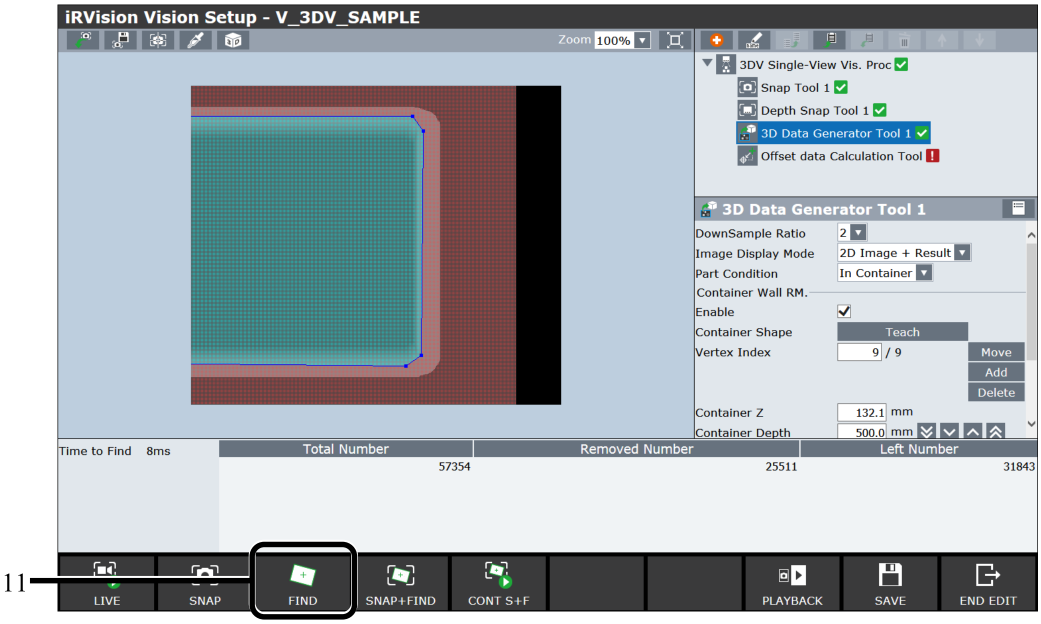


9 Repeat steps 5 to 8 to set all [Vertex Index] of current view.

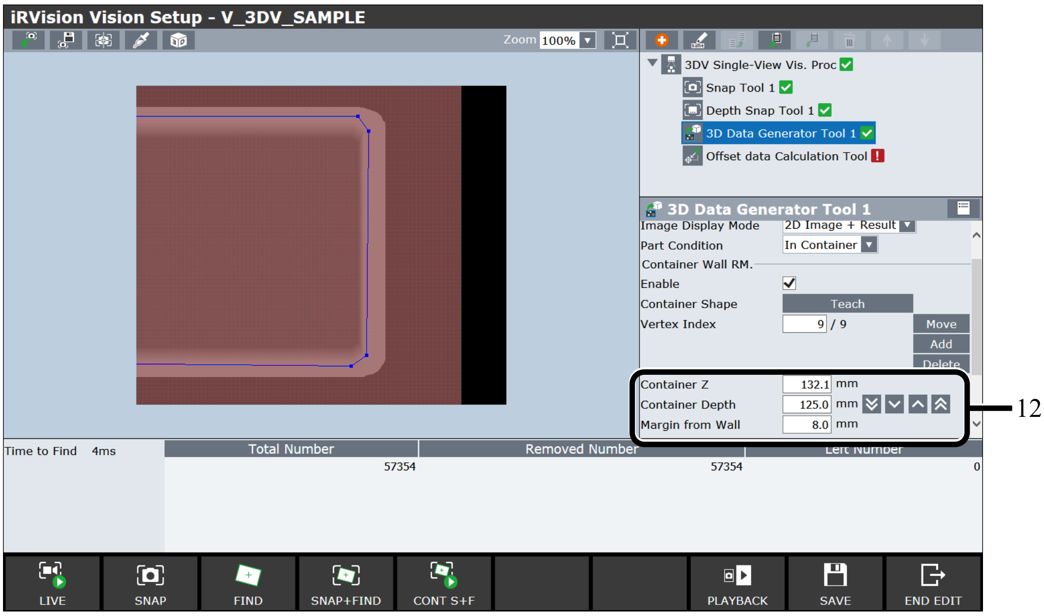


10 If necessary, repeat steps 4 to 9 until all the container vertices are set.

11 Click the [FIND] button.

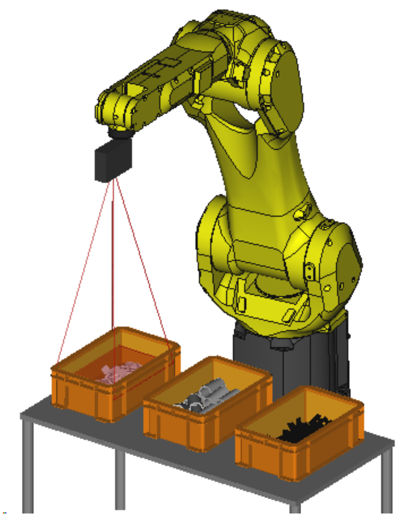


12 Adjust [Container Z], [Container Depth] and [Margin from Wall] if the 3D points of the bottom of the container or outside the container are not properly removed.
For how to adjust them, refer to the description of 3D Data Generator Tool in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."
After completing adjustment of each parameter, the setting is completed.

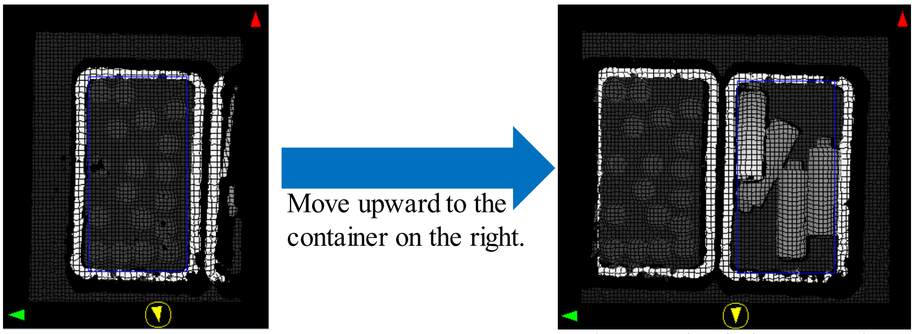


3.4.2 Using Robot-Mounted Camera for Multiple Containers

As shown in the figure below, if there are multiple containers of the same type and you want to move the robot with the robot-mounted camera to each container and to perform detection, use [Camera Base Find].



For the setup procedure, refer to '3.2.1 Moving the Search Window of the 3D Command Tool with the Robot-mounted Camera According to the Snap Position of the Robot.'



The search window onto the container next to the right.

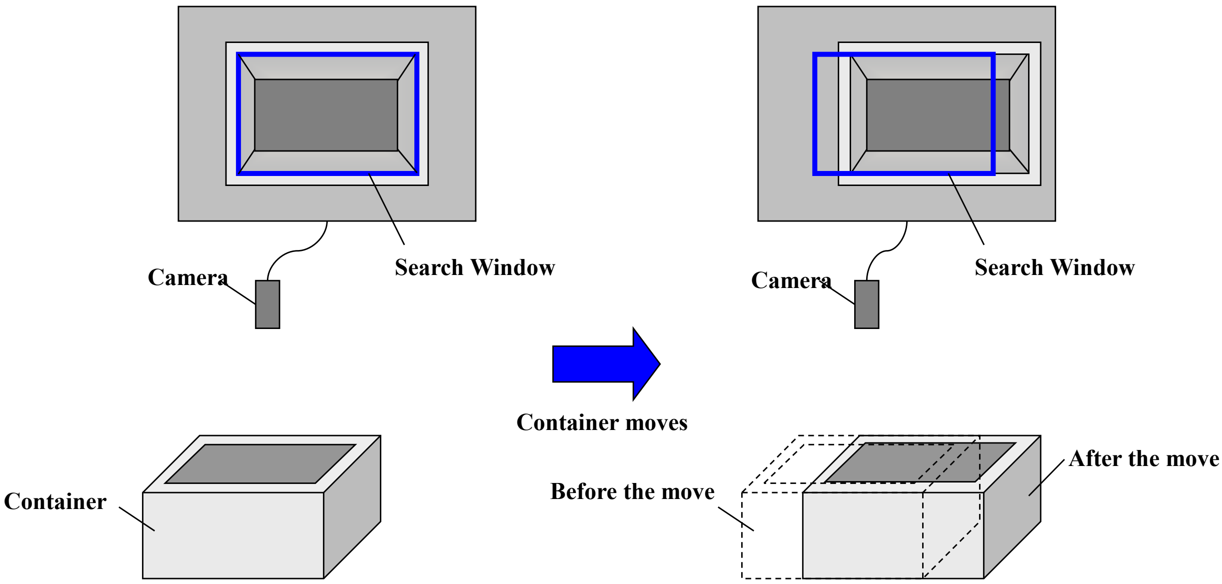
When [Camera Base Find] is disabled, the search window does not change from the set area even if the robot moved to above another container.

3.4.3 Container Position Is Not Fixed

In a bin-picking system, because the container will not be positioned correctly due to the nature of the mechanism or because it is positioned to a certain degree but the clearance is relatively large, the container installation position may change each time when it is replaced, causing the following problems.

- A misjudgment frequently occurs with the interference avoidance function.
  The container object set in the system data for interference avoidance memorizes the container position and size based on three points in the reference user frame set in the system data. For this reason, if the container installation position changes, the memorized position of the container object and the actual position of the container will not match, resulting in a misjudgment on interference.

- The search window cannot be set correctly.
  The part search window set by the SEARCH vision process is normally set along the internal wall of a container in which the part is present. However, if the container installation position moves, the search window will not be set correctly along the internal wall of the container, resulting in parts that cannot be found (see the figure below).



If this is the case, use a function that automatically moves the container object and search window. This function uses the found result of a vision process for finding the container installation position to internally move them.

Creating and setting a container detection vision process

On the [Vision Setup] screen of *i*RVision, create and set a vision process for finding a container. 2-D Single-View Vision Process or 2-D Multi-View Vision Process are useful for container detection. For details, refer to the descriptions of 2-D Single-View Vision Process or 2-D Multi-View Vision Process in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

Changing the TP program

The following describes how to change the TP program explained in "Setup: 4 BIN PICKING SYSTEM" to one that uses the result of container detection for bin-picking. A TP program can also be customized in other bin-picking system using the same method.

In this customization, the following registers are used in addition to those used in the TP program explained in "Setup: 4.8 CREATING TP PROGRAM."

Additional registers to be used

R [15]	The maximum retry count for container detection.
R [16]	The retry count for container detection.

The following vision register is additionally used.

Additional vision register to be used

VR [1]	The container detection result.

BIN_FIND_CONTAINER.TP

Add a TP program that performs container detection. When obtaining the offset value fails, a retry is repeated for the number of times set in R [15]. When the retry count has exceeded the value in R [15], a user alarm is issued. Note that in the following TP program, the vision process for container detection is named CNTROFS.

```
! Move to snapping position
J P[2] 100% FINE

R[15]=5
R[16]=0

LBL[10]
! Check retry times
IF R[16]>R[15],JMP LBL[99]

! Run CONTAINER OFFSET process
VISION RUN_FIND 'CNTROFS'
VISION GET_OFFSET 'CNTROFS' VR[1] JMP LBL[91]

END

! Retry CONTAINER OFFSET process
LBL[91]
R[16]=R[16]+1
JMP LBL[10]

! ALARM
LBL[99]
UALM[2]
END
```

- J P[2] 100% FINE: Move to a position to snap an image.
- R[15]=5: Set maximum number of times to retry.
- R[16]=0: Set 0 to the number of times retry.
- IF R[16]>R[15],JMP LBL[99]: Terminate the cycle if the number of times of retry exceed the maximum number of times.
- VISION GET_OFFSET 'CNTROFS' VR[1] JMP LBL[91]: Run the vision process for CONTAINER OFFSET
- R[16]=R[16]+1: Count the retry times
- JMP LBL[10]: Jump to the process to check the retry times

BIN_PICKING.TP

Change the section indicated with a bold line of the TP program BIN_PICKING.TP explained in "Setup: 4.8 CREATING TP PROGRAM."

```
!The register numbers and
!position register numbers below
!should be changed according to
!those set by CMT_3DV_BP.TP.

UFRAME_NUM=1
UTOOL_NUM=1
CALL BINPICK_CLEAR(1)

CALL BINPICK_FIND_CONTAINER

!SEARCH
LBL[1]
L P[1:Search] 2000mm/sec FINE
CALL BINPICK_SEARCH(1,1,10)
IF R[10]<>0,JMP LBL[999]

!POP

```

Add the instruction for calling the program for CONTAINER OFFSET

3.4.3.1 Moving container objects for interference avoidance data according to amount of movement of container

On the edit screen for the interference avoidance setting system data, enter the vision register number that stores the result of the above-mentioned container detection vision process in [VR] under [Container Offset] in the setting item area.

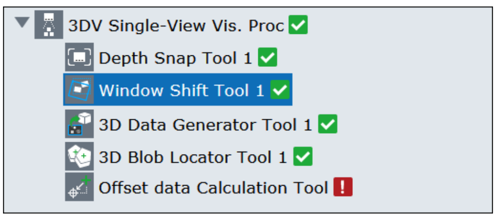
In the tree view of the edit screen for the interference avoidance setting system data, select an object that moves with the container. Check the checkbox of [Shift Objects Pos.] in the setting item area.

3.4.3.2 Shifting Search Window according to amount of container movement

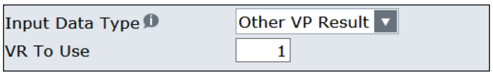
The following explains how to shift the search window according to the amount of container movement. Configure the following settings in the "3DV Single-View Vision Process" created for bin-picking.

Adding and teaching the window shift tool

Add a window shift tool to the "3DV Single-View Vision Process."



Select [Window Shift Tool 1] in the tree view of the vision process edit screen, and select [Other VP Result] from the [Input Data Type] drop-down box in the setting item area. Enter the vision register number for storing the result of the container detection vision process in the text box for [VR to Use] that appears when [Other VP Result] is selected.



Teaching 3D Data Generator Tool and 3D Blob Locator Tool

Once the container detection vision process is run from the TP program, obtain the vision offset value and store the result in the vision register. Then, teach the container shape on the 3D Data Generator Tool edit screen. When a search window is being used by the 3D Blob Locator Tool, and so on, teach the search window again. For details on the setting method, refer to the description of 3D Data Generator Tool and 3D Blob Locator Tool in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."

3.5 COMMAND TOOL

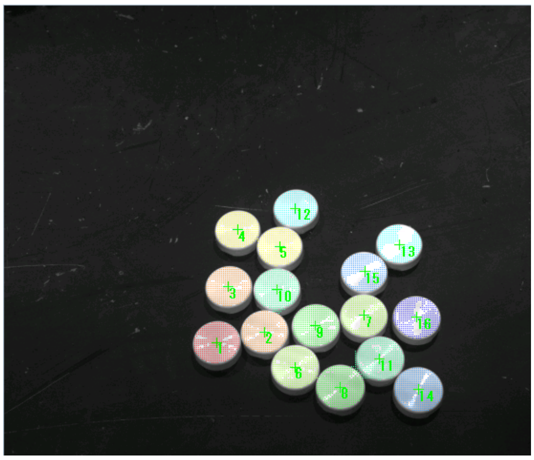
3.5.1 Using 3D Blob Locator Tool for Close Contact Parts

Because the 3D Blob Locator Tool uses the difference in height with the surroundings to detect parts, when parts are in close contact with each other, several parts may be connected and detected as one part. In such a case, if the boundaries between parts can be distinguished by the camera image, connected 3D blobs may be separated by utilizing the camera image.

1 Create 3DV Single-View Vision Process and click the [Edit] button to open the setup screen.
2 Click the button in the tree view to add [Snap Tool].
3 Select [3D Blob Locator Tool] in the tree view and select the added Snap Tool in [Input Image].
4 Enable [Contrast] of [Connecting Threshold].

The following figures show the detection results when [Contrast] is disabled/enabled.

Invalid



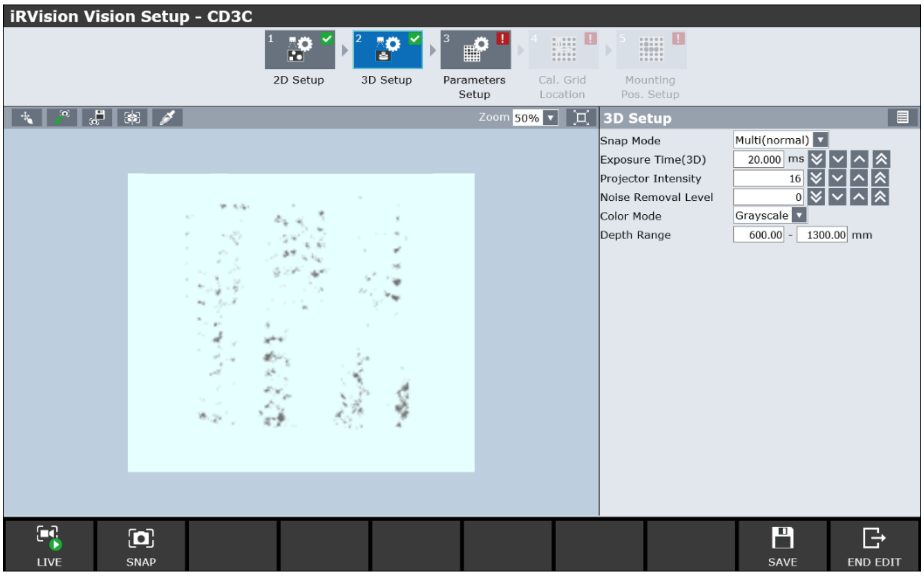
Valid

4 TROUBLESHOOTING

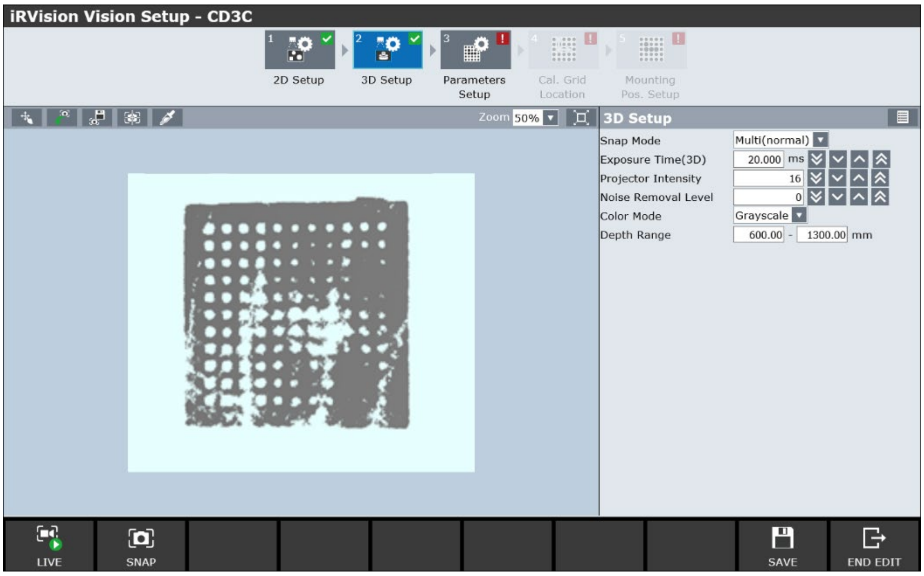
This chapter explains how to troubleshoot if any failure happens while using the 3DV Sensor.

4.1 DISTANCE CANNOT BE MEASURED

If a strong impact or vibration is applied to the 3DV Sensor, the measurement performance may degrade as the following figure.
In such a case, you can re-adjust the 3DV Sensor.
For details, refer to the description about re-adjusting the 3DV Sensor in "*i*RVision OPERATOR'S MANUAL (Reference) B-83914EN."



Failure case



Normal case

INDEX

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REVISION RECORD

Edition	Date	Contents
04	Nov., 2021	• Applied to series 7DF5/17 (V9.40P/17)
03	Feb., 2021	• Applied to series 7DF5/06 (V9.40P/06) • Applied to R-30*i*B Mini Plus controller
02	Oct., 2020	• Applied to series 7DF3/06 (V9.30P/06) • Applied to R-30*i*B Compact Plus controller
01	Feb., 2019	

B-83914EN-3/04

B-83914EN-3/04