

Cognex In-Sight[®] 2D Robot Guidance Plug-in User Guide







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Integrating with Universal Robots - TCP/IP

Cognex 2D vision systems integrate with Universal Robot controllers using the Cognex In-Sight 2D Robot Guidance plugin, which you install in the Universal Robot PolyScope software. Use this plugin to set up hand-eye calibration and retrieve the position (pose) information from the vision system so that the robot can move to the correct target location and pick up the part. You can program responses from the vision system, such as when a job passes or fails. You can also set a reference pose for the robot if the vision system is mounted to the robot arm.

Cognex 2D vision systems communicate with Universal Robot controllers using a TCP/IP connection. The vision system hosts the TCP server and the robot is the client. These devices must be on the same network.

() Note: This feature is not supported on In-Sight 2000 vision sensors.

The following Universal Robots are supported:

- UR3
- UR5
- UR10
- e-Series

The Cognex In-Sight 2D Robot Guidance plugin is supported only in Universal Robots PolyScope software version 3.5.1 and later.

Setting up the hand-eye calibration and robot guidance application involves the following tasks:

- 1. Install the Cognex In-Sight 2D Robot Guidance Plugin on page 5
- 2. <u>Teach the Robot Tool Center Point (TCP) on page 6</u>
- 3. Configure the Vision System for Calibration on page 8
- 4. Connect to the Vision System and Perform Hand-Eye Calibration on page 11
- 5. Create a Part Job and Import the Calibration on page 15
- 6. Set Up the Vision System Pose on page 17
- 7. Program the Universal Robot on page 21

Install the Cognex In-Sight 2D Robot Guidance Plugin

- 1. Go to cognex.com/urcaps and download the Cognex URCaps v1.3.0.urcap file.
- 2. Transfer the file to a USB stick.
- 3. Launch the PolyScope program. The main menu displays:

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ot

- 4. Insert the USB stick into the right side of the Universal Robot teach pendant.
- 5. On the main menu, select **Setup Robot > URCaps**. Click the plus button (+) to add the URCap Cognex plugin file, which displays as **Cognex In-Sight Robot Guidance**.

æ	Univers	al Robots Graphical Programming Environment	- + ×
		Setup Robot	0
	Initialize Robot	URCaps	
	Language	Cognex In-Sight Robot Guidance	
	Update		
	Set Password	URCap Information	
	Calibrate Screen		
	Network		
	Time		
	URCaps		
	Back		() Restart

The Cognex In-Sight 2D Robot Guidance plugin adds the following to the PolyScope software:

- A Cognex menu item on the Program tab (Program > Structure > URCaps > Cognex Camera Pose).
- A Cognex menu item on the Installation tab.
- A node in the Robot Program tree called CGX_result:=CameraPose.
- A new variable called CGX_result is added to the Program > Command tab. This variable is used to store the vision system pose information that is sent from the vision system during triggering.

Teach the Robot Tool Center Point (TCP)

The tool center point (TCP) is the part of the robot that contacts the work part. You teach the TCP so that the robot can move to the same position from multiple angles (called "waypoints").

The TCP must be within the field of view of the vision system.

() Note: This procedure is inherent to the PolyScope software and is included in this document for convenience.

- 1. Launch the PolyScope software.
- 2. On the main menu, select Program Robot. The New Program window opens.

\$	Un	lversal	Robo	ts Gra	phical Program	nming Envir	ronment		- + ×
R 🗿 File								16:09:41	cccc 🕜
Program	Installation	Move	NO.	Log					
				N	ew Prog	ram			
	Load From	File							
					Load Progra	m			
	Use Templ	ate							
					Pick and Plac	æ			
					Empty Progra	m			

3. Select Pick and Place.



4. Select Installation > TCP Configuration.

File					20:20:24	CCCC (7)
Program Installatio	n Move	r vo r	Log			
TCP Configuration		5	Setu	p for the Tool	Center Poin	ıt
Mounting	Availab	le TCPs:				
I/O Setup	🛷 T(CP	-	Set as default	+	
🚱 Safety	×	0.0	nm		© Y	•
Variables	Y	5.0	nm 📄	Position		X
MODBUS	z	0.0 r	nm 📄	arrientation		
Features	RX	0.0000				·
Base Tool	RY	0.0000		New	CHU	
Conveyor Tracking	RZ	0.0000		Remove		
EtherNet/IP	Padoa	+ 0.	00 ka			
PROFINET	- Cer	ter of ors			< <u>z</u>	
Cognex	a	0.0	nm			
Default Program	CY	5.0	nm			
Load/Save	cz	0.0	nm			

- 5. To teach the TCP, you can measure them manually in one of the following ways:
 - If the TCP is located directly on the Z axis, measure the distance between the TCP and the center of the tool flange (in millimeters) for the Z axis. Enter the measurement in the Z field.
 - If the TCP is NOT located directly on the Z axis, measure the distance between the TCP and the center of the tool flange (in millimeters) for the X, Y, and Z axes. Enter the measurements in the X, Y, and Z fields, respectively.

Refer to the PolyScope Manual for additional instructions. You can download this manual from the Universal Robots web site.

Configure the Vision System for Calibration

In this procedure, you will:

- Train the pattern of the robot TCP so that it can be located by the vision system.
- Add a Robot Tool.
- Enter a name for the .CXD calibration file. This file will be populated with calibration information by the Cognex In-Sight 2D Robot Guidance plugin after it completes the calibration.
- 1. In EasyBuilder, connect to the vision system, then create a new job.
- 2. Select Set Up Image. Ensure that the tool center point is within the field of view of the vision system.
- 3. Under Edit Acquisition Settings, set the **Trigger** to **Manual**.

- Edit Acquisition Settings-		
Trigger	Manual	
Trigger Delay (msec)	0 🖕	
Trigger Interval (msec)	500 🗘	
Exposure (msec)	8.000	=
Start Row	0	
Number Of Rows	3000	
Gain	60	
HDR Mode	Disabled 💌	
HDR Kernel Size	Large	
	Focus Pegion	-

- 4. Adjust the image settings to get an image that is well focused and evenly illuminated.
- 5. Select Locate Part and add any preferred tools for locating the TCP on the robot gripper.
- 6. Highlight the PatMax Pattern Tool and select Settings.

7. Use **Horizontal Offset** and **Vertical Offset** settings to adjust the crosshair on your tool so that it is centered on the TCP.

🚳 In-Sight Explorer - admin - (gu/7802_4e949c_sps - 7802 - C1Users/vgu/mil/Desktop/U/R Custom/U/RS/wee/Cogness/ision/Camera Files/Lob Files/U/R7802_lob) 🗕 🗖 🗙
Nie Edit View Image Sersor System Window Help 📃 🗗 🔀
1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Application Steps 1. Start Connected Set Up Image 2. Set Image 3. Set Imag
Add Tool Teat Add Add Concra: Settings Trained Image Model Search Model Region Add Add Concra: Settings Trained Image Model Search Model Region Model Regi

- 8. Next, to add the Robot Calibration Tool, select Inspect Part > Calibration Tools > Robot.

9. Select Add.

Note: This tool also uses Smart Features, so you can use other features (such as circles) to link to the Robot Calibration Tool.

10. On the image, click on the crosshair associated with the tool that is used to define the TCP, then click **OK**. The Robot Tool displays in the Results tab of the Palette and is connected to the Pattern tool.

I RESULS	Palette							
2	Name	Result	Type					
	Pattern 1 Calib_1	(2374.5.1214.1) 0.0° s Pass	PatMax [®] Pat_ Robot					

- 11. Select the Robot Calibration Tool in the Tool Palette (named Calib_1 by default).
- 12. Under Edit Tool, select the Settings tab.

- Edit Tool		
General Settin	gs	
File Name	Default	
Full Name	DefaultCalib	
Append Date/Time		

- 13. Enter a **File Name** of the .CXD calibration file. To optionally include the current date and time in the file name, mark the **Append Date/Time** check box. The **Full Name** field displays the complete file name.
- 14. Set the vision system to Online. This is required for the vision system to communicate with the robot.
- 15. Save the job with a name that indicates that this is a calibration job. If you need to re-run the calibration in the Cognex In-Sight 2D Robot Guidance plugin, you can reuse this job.

Connect to the Vision System and Perform Hand-Eye Calibration

You perform a hand-eye calibration using the Cognex In-Sight 2D Robot Guidance plugin. This establishes the work plane within the field of view of the vision system, which determines the area where the robot can manipulate a part. The plugin creates a calibration file (.CXD) that you will later import into your main job.

Begin the calibration by defining three set points that will determine the height and width of the work plane.

- 1. On the PolyScope main menu, select **Program > Robot > Installation > Cognex**. The Cognex window opens.
- 2. Under **Connection**, enter the **IP Address** of the vision system. The vision system name displays below that address.



If the connection fails, refer to the following information to troubleshoot:

If this error displays:	Do the following:
Make sure the camera is online and the proper job file is loaded.	In In-Sight Explorer, check that the camera is Online.
The format of the IP address is invalid (example address: 192.168.0.1)	In the robot software, check that the correct IP address for that camera is entered.
Timeout reached. Make sure the network adapter is enabled in Setup Robot Network.	In the robot software, check that the robot is on the correct network.

3. Visually establish and make note of the size of the work plane that will include the part to be picked up by the robot. The graphic below illustrates sample points of width and height.

Note: In steps 4 through 6 below, before you click **OK**, you can verify that the vision system can still see the TCP by triggering an image manually in In-Sight EasyBuilder.



4. First, you will define the width of the work plane. Select the **Set Point** button for (1) Work Plane Corner. The **Move** tab displays. Use the controls to move the robot to the first corner point of the work plane, then select **OK**. A green check mark displays next to the first **Set Point** button on the Cognex window.

COGNEX	
Connection	
C IP Address: 192.168.0.1	
Camera name: gui7802_4e949c_sps	
Calibration	
Width:	width v
(1) Work Plane Corner Set Point	Y TY
(2) Work Plane Corner Set Point	Height
Height:	x x x
(3) Work Plane Edge Set Point	
Start Calibration	<u></u>

 Select the Set Point button for (2) Work Plane Corner. The Move tab displays again. Use the controls to move the robot to the second corner of the work plane, then select OK. A green check mark displays next to the second Set Point button on the Cognex window.

COGNEX	
Connection	
C IP Address: 192.168.0.1	
Camera name: gui7802_4e949c_sps	
Calibration	
Width:	🕜 Width 🗸 💦 💽
(1) Work Plane Corner Set Point	
(2) Work Plane Corner Set Point	teight
Height:	
(3) Work Plane Edge Set Point	
	<u>॑</u> ×- <u>(</u>) <u></u> k
Start Calibration	1

6. Next, you will define the height using the third set point. Select the Set Point button for (3) Work Plane Edge. The Move tab displays again. Use the controls to move the robot to be in line with the far edge of the work plane, then select OK. A green check mark displays next to the third Set Point button on the Cognex window. The Width and Height display.

The Start Calibration button is now enabled.

COGNEX	
Connection	
C IP Address: 192.168.0.1	
Camera name: gui7802_4e949c_sps	
Calibration	
Width: 57.50 mm	Width X
(1) Work Plane Corner Set Point	T
(2) Work Plane Corner Set Point	eight
	x x x
Height: 236.71 mm	
(3) Work Plane Edge Set Point	<u></u>
Start Calibration	

- 7. Before you start the calibration, review the width and height again to make sure they are satisfactory.
- 8. To begin calibration, select **Start Calibration**. When the calibration completes, the following message displays: **Calibration has finished**.
- 9. Select Start Program or Continue to close the window.

During calibration, the following occurs:

- The robot program directs the robot to 15 points within the field of view, and sends the coordinates to the vision system.
- The vision system acquires an image and determines the TCP location.
- The robot program maps the TCP coordinates to the vision system pixel coordinates.

When the calibration finishes, the Cognex In-Sight 2D Robot Guidance plugin does the following:

- Sends a message to the Robot tool of the calibration job that you previously created.
- Creates a calibration file with the file name you entered in the calibration job, along with a .CXD extension. You
 will import this calibration into your main job, which is where you will also train the part to be picked by the robot.

• Note: If the vision system is mounted to the robot arm, do not move the trained part until you have set the reference pose for the robot. You set the reference pose of the robot after you set the vision system pose.

Create a Part Job and Import the Calibration

Create your main job to train the part to be picked up by the robot and to import the calibration created by the Cognex In-Sight 2D Robot Guidance plugin.

- 1. Create a new job and connect to the vision system. Ensure that the pick up part is within the field of view of the vision system.
- 2. Select Set Up Image
- 3. Under Edit Acquisition Settings, set the Trigger to Manual.

Edit Acquisition Settings				
Trigger	Manual	-		
Trigger Delay (msec)		0 🌲		
Trigger Interval (msec)		500 🌲		
Exposure (msec)		8.000 🌲	=	
Start Row		0		
Number Of Rows		3000 🌩		
Gain		60 🌲		
HDR Mode	Disabled	-		
HDR Kernel Size	Large	~		
L	Focus Per	lion	-	

4. Under Calibration Type, select Import.

Calibrate Image to Rea	al World
Calibration Type:	
None	-
Edge to Edge	-
X/Y Edge-to-Edge	
Circle	
9-Point	=
Grid	
Import	-

5. In File Name, select the .CXD name you entered in the calibration job.



- 6. Select Locate Part and add any preferred tools for locating the part.
- 7. Perform additional job setup, if applicable.
- 8. Select Inspect Part.

9. Select Math & Logic Tools > Robot Guidance.



10. Select **Add**, click on the crosshair of the part, then select **OK**. The **Robot Guidance** Tool displays in the Results tab of the Palette and is connected to the Pattern Tool.

 Name Name	Result	Type
Pattern 1	(-370.1265.0) -6.4* score = 88.9	Pattern
Guidance_1	Pass	Robot Guidance

- 11. Under Edit Tool, change the **Tool Name** and any settings, as necessary. Customize your tool by giving it a name that is associated with your particular application.
- 12. Set the vision system to Online.

Set Up the Vision System Pose

You set up vision system pose options so that the robot program contains the proper location of the vision system.

1. Launch the PolyScope program that you created. The main menu displays:



2. In the PolyScope main menu, select Program Robot. A list of tabs display.

🛃 Universal	Robots Graphical Programming Environmen	t	- + ×
🖉 File		16:09:41	cccc 🕜
Program Installation Move	VO Log		
	New Program		
Load From File			- I
	Load Program		
Use Template			
	Pick and Place		
	Empty Program		

3. Select Empty Program.



4. Select the **Structure** tab. The Program Structure Editor page displays.



5. Select the **URCaps**. The **Cognex Camera Pose** button displays, which represents the Cognex In-Sight 2D Robot Guidance plugin.

R 🛛 File		23:11:21 C	ccc 🕜
Program Installation	Move VO Log		
sunnamed>	Command Graphics Structure Variables		
Robot Program ♥ CGX result - Conversionse • ♥ Job Pass • ♥ MoveL • ● CGX result • ♥ Job Fall • = compty> • ♥ No Response • ● compty>	Program Structure Editor Set placement of node [After selected] • Insert Basic Advanced Wizards URCaps		
	Edit Edit Move Copy Paste	Supj	press
 I I	Move Cut Delete		
Simulation Real Robot	Speed	Previous	Next 🌩

Select the Cognex Camera Pose button, then select the Command tab. The Robot Program tree on the left now contains the CGX_result;=CameraPose node and three additional nodes: Job Pass, Job Fail, and No Response.

Ur	niversal Robots Graphical Programming Environment	- + ×				
🔽 🧿 File	00:13:43	cccc 🕜				
Program Installation	Move VO Log					
<pre>unnamed></pre>	Command Graphics Structure Variables					
▼ Robot Program • ▼ COX_resultCameral • ▼ MoveL • ▼ MoveL • ♥ Ø MoveL •	Cognex Camera Pose Each time this node is run, the camera will trigger and the pose that repre- tive location of the norm will be stored in the specified variable. COX_result	sents				
	Create new A locked portion of the pose will use the Robot's current position or orientation					
	Lock Rotation					
	Lock X Position					
	Lock Y Position					
	🗹 Lock Z Position					
	Set a reference pose to use in place of current robot pose					
	Set Reference Pose Clear Robot Mounted					
	Connection Info: Not Connected to Camera 10.28.96.119					
Simulation Real Robot	Speed Ologie Previou:	s Next 🌩				

- 7. A file named **CGX_result** is created that will be used to store the vision system pose. The pose corresponds to the location of the part found by the vision system.
- 8. Lock any positions that you do not want to be obtained by the vision system. If you leave all rotations unlocked, the robot rotation will be relative to the current rotation at the robot gripper, which is the rotation set when the program reaches the **CGX_result;=CameraPose** node. To lock a position, mark the appropriate check box.
- 9. Save the program.

• Note: If the vision system is mounted to the robot arm, set a reference pose for the robot. Refer to <u>Set a Reference</u> <u>Pose for the Robot on page 20</u>.

Set a Reference Pose for the Robot

• Note: This task is required only if the vision system is mounted to the robot arm (optional if the vision system is not mounted to the robot arm).

You can set a reference pose for the robot, so that the robot gripper is aligned with the trained part.

 In the Robot Program tree of PolyScope, select the CGX_result;=CameraPose node. The Cognex Camera Pose window displays.



2. Select Set Reference Pose. The Move Tool displays.

🛃 Universal R	obots Graphical Programming Environment		- + ×
🖉 🕈 File		00:22:00	cccc 🕜
Program Installation Move	VO Log		
Hove Tool		Feat View TCP X [Y] Z [RX] RZ]	216.83 mm -386.70 mm -253.80 mm 1.2084 -2.9142 -0.0515
	Move Joints Base Shoulder Elbow Wrist 1 Wrist 2 Wrist 3		Home -91.71 • -98.96 • 126.22 • -46.29 • 91.39 • -1.78 •
Simulation Real Robot	Speed 🔤 🖓 100%	X Cancel	🗸 ок

- 3. Use this tool to move the gripper so that it is aligned with the trained part.
- 4. When finished, select OK.
- If the vision system is mounted to the robot arm, mark the Robot Mounted check box.
 If the vision system is not mounted to the robot arm, leave this check box unmarked.
- 6. To save the reference pose, save your program.

Program the Universal Robot

After you set up the robot calibration and In-Sight jobs, you can then program the robot for your pick and place application using MoveL and other robot commands. You can also determine the action to take when a job passes, fails, or if there is no response from the vision system. The Cognex In-Sight 2D Robot Guidance plugin provides the following framework to start:

🛃 Ur	liversal Robots Graphical Programming Environment		- + ×
<u> (</u> File		15:51:13	cccc 🕜
Program Installation	Move I/O Log		
<pre>unnamed></pre>	Command Graphics Structure Variables		
lobot Program ©CX result.=CameraPose ♀ ▼ Job Pass ♀ ♥ Movel. ↓ ● CCX result ♀ ♥ Job Fail ↓ ● CX result ↓ ● CX result	Program Structure Editor Set placement of node After selected v Insert Basic Advanced Wizards URCaps Cognex Camera Pose		
C Sal Rabot	Edit Move Copy Paste Move Cut Delete Speed 0100%	Previous	Suppress

When you finish programming and run the application, when the program reaches the **CGX_result:=CameraPose** node, the following occurs:

- 1. The robot communicates to the camera for location of the trained part.
- 2. The vision system triggers and returns the pose that represents the location of the part.
- 3. The pose is stored in the CGX_result variable in the Program Structure Editor in PolyScope.

The following is a sample program structure:

