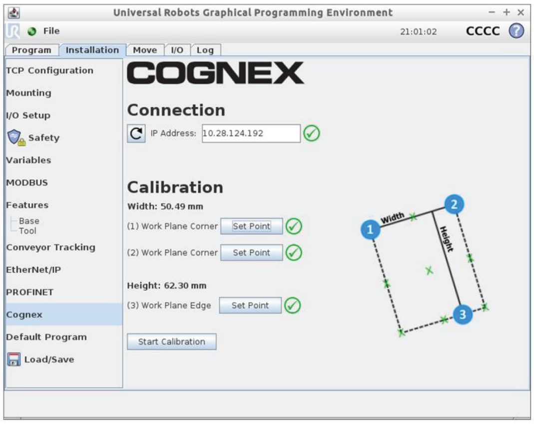
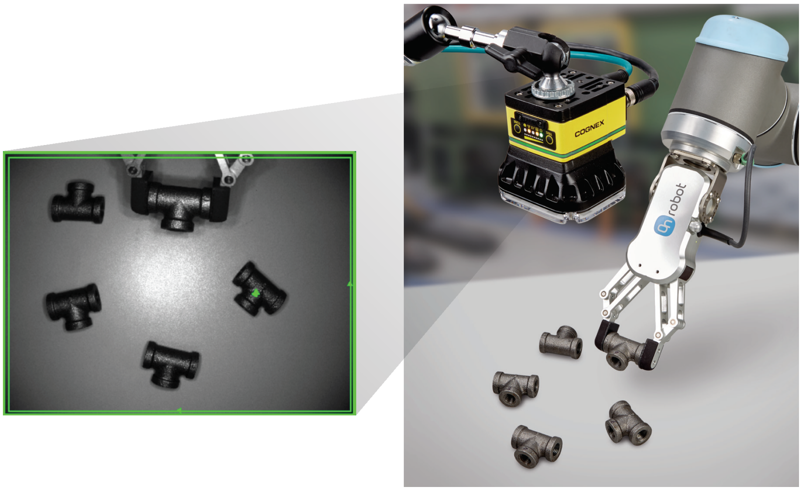
# Cognex In-Sight® 2D Robot Guidance Plug-in

## User Guide



2021 July 01
Revision: 5.9.2.7

# Legal Notices

# Table of Contents

# 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.

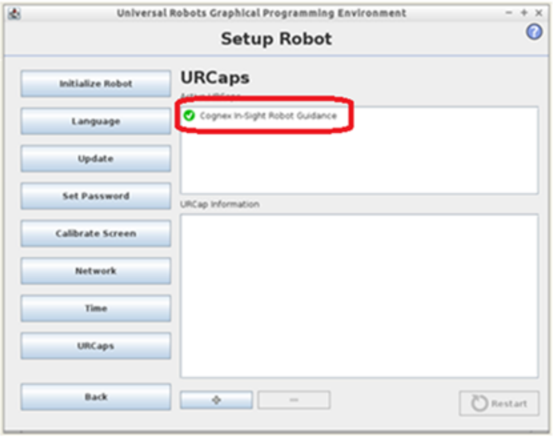
Setting up the hand-eye calibration and robot guidance application involves the following tasks:

1. *Install the Cognex In-Sight 2D Robot Guidance Plugin* on page 5
2. *Teach the Robot Tool Center Point (TCP)* on page 6
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:


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**.




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)

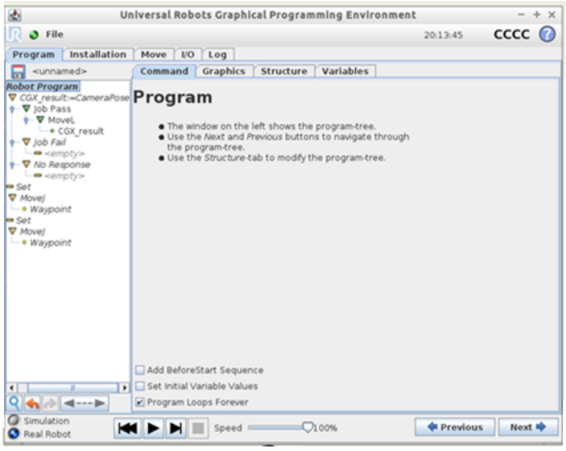
The tool center point (TCP) is the part of the robot that contacts the work part. You teach the TCP so that the robot can move to the same position from multiple angles (called "waypoints").

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

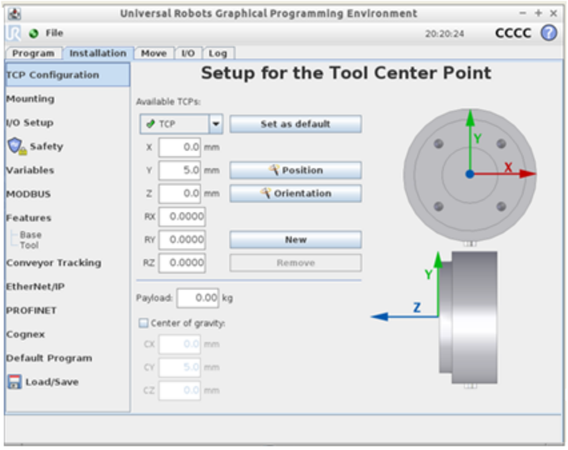
**Note**: This procedure is inherent to the PolyScope software and is included in this document for convenience.

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


3. Select **Pick and Place**.



4. Select **Installation > TCP Configuration**.




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.

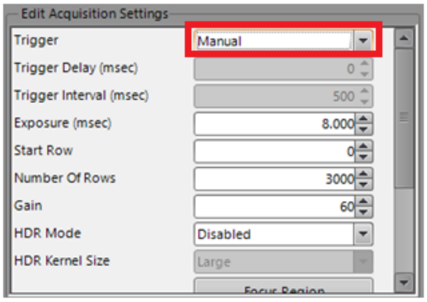
   Refer to the PolyScope Manual for additional instructions. You can download this manual from the Universal Robots web site.

# Configure the Vision System for Calibration

In this procedure, you will:

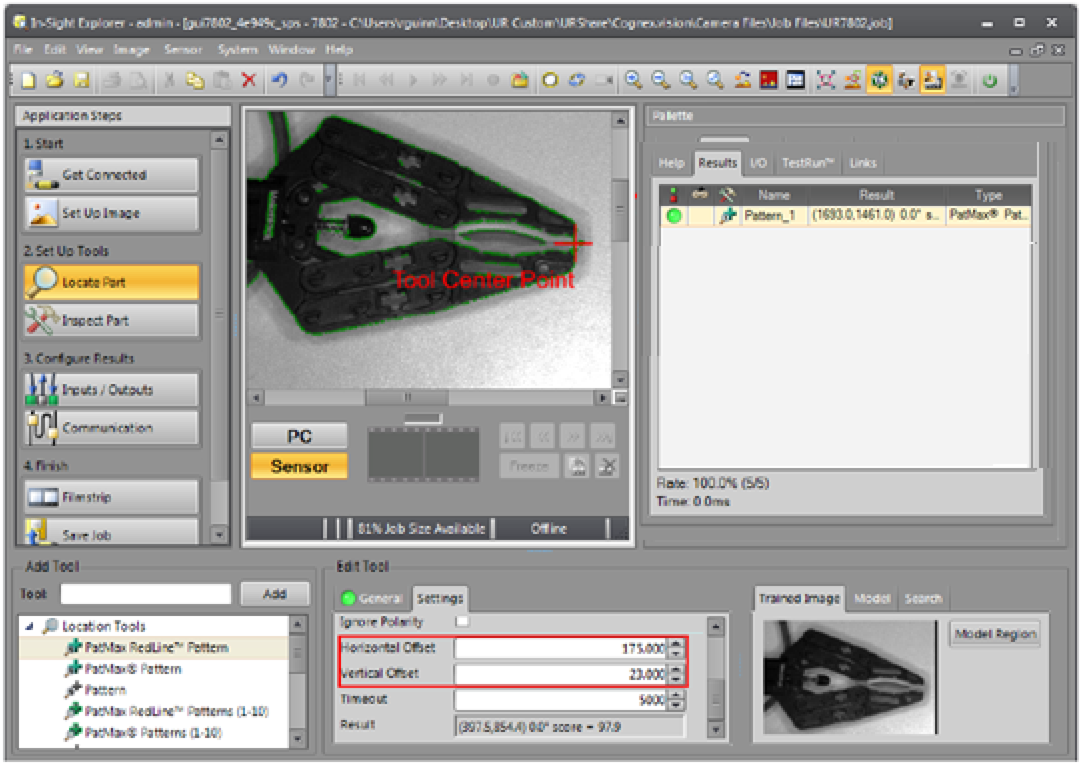
- Train the pattern of the robot TCP so that it can be located by the vision system.
- Add a Robot Tool.
- Enter a name for the .CXD calibration file. This file will be populated with calibration information by the Cognex In-Sight 2D Robot Guidance plugin after it completes the calibration.

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**.

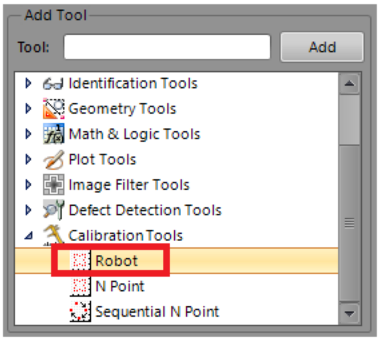



4. Adjust the image settings to get an image that is well focused and evenly illuminated.
5. Select **Locate Part** and add any preferred tools for locating the TCP on the robot gripper.
6. Highlight the **PatMax Pattern** Tool and select **Settings**.

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



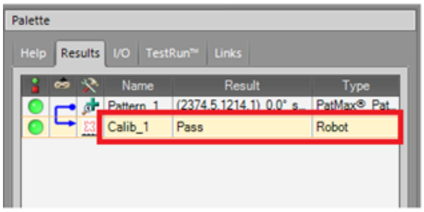

8. Next, to add the Robot Calibration Tool, select **Inspect Part > Calibration Tools > Robot**.



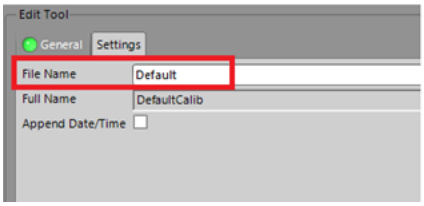

9. Select **Add**.

> **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.




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



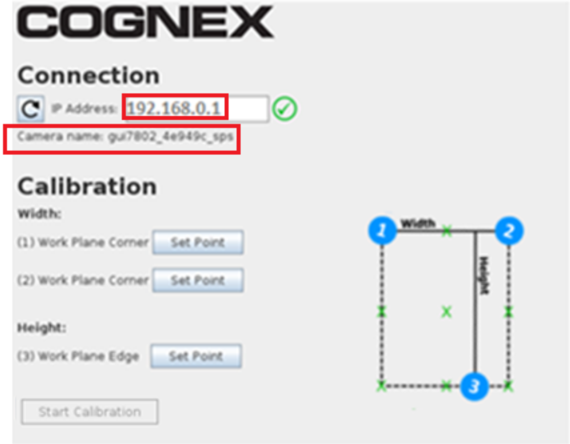

13. Enter a **File Name** of the .CXD calibration file. To optionally include the current date and time in the file name, mark the **Append Date/Time** check box. The **Full Name** field displays the complete file name.
14. Set the vision system to Online. This is required for the vision system to communicate 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.

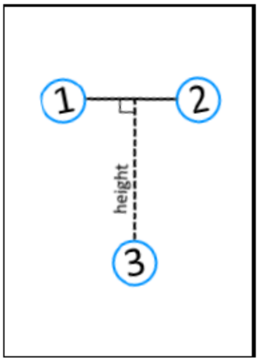



If the connection fails, refer to the following information to troubleshoot:

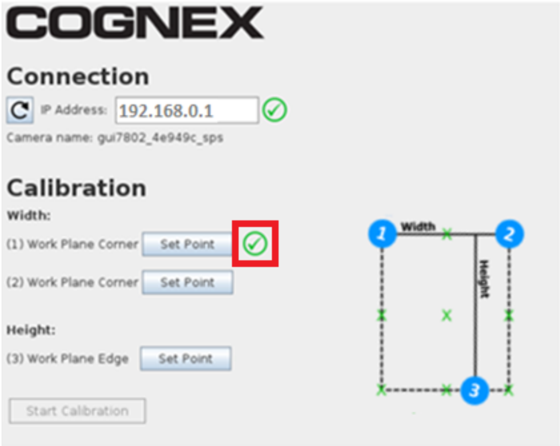
| If this error displays: | Do the following: |
|---|---|
| Make sure the camera is online and the proper job file is loaded. | In In-Sight Explorer, check that the camera is Online. |
| The format of the IP address is invalid (example address: 192.168.0.1) | In the robot software, check that the correct 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.

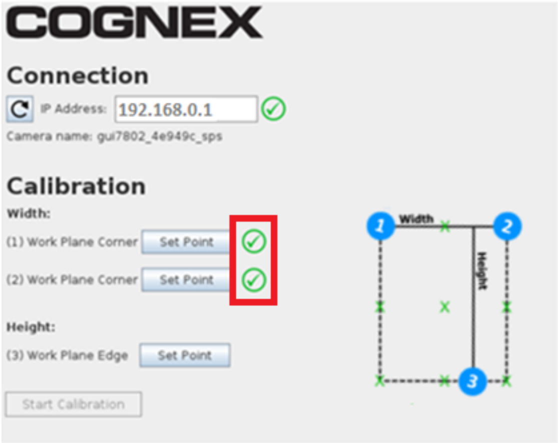
> **Note**: In steps 4 through 6 below, before you click **OK**, you can verify that the vision system can still see the TCP by triggering an image manually in In-Sight EasyBuilder.




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.

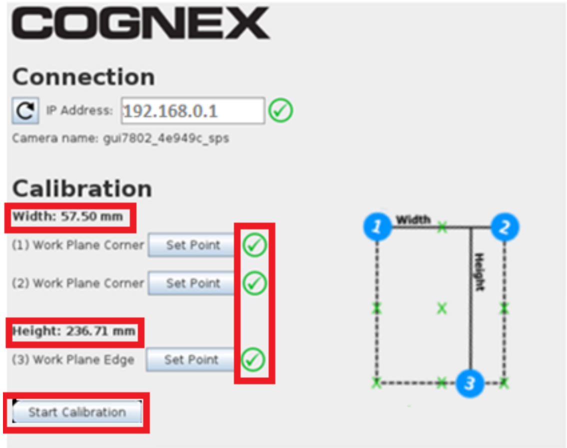


5. Select the **Set Point** button for (2) Work Plane Corner. The **Move** tab displays again. Use the controls to move the robot to the second corner of the work plane, then select **OK**. A green check mark displays next to the second **Set Point** button on the Cognex window.




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.




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:

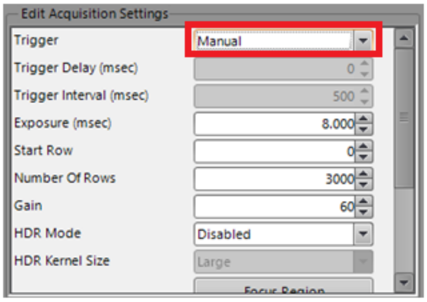
- Sends a message to the Robot tool of the calibration job that you previously created.
- Creates a calibration file with the file name you entered in the calibration job, along with a .CXD extension. You will import this calibration into your main job, which is where you will also train the part to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

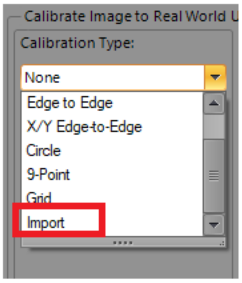
# Create a Part Job and Import the Calibration

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.

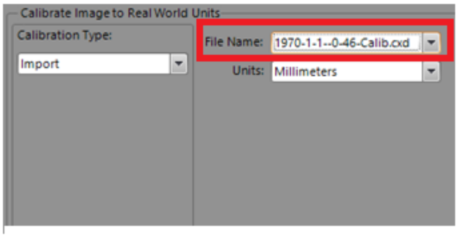
1. Create a new job and connect to the vision system. Ensure that the pick up part is within the field of view of the vision system.
2. Select **Set Up Image**
3. Under Edit Acquisition Settings, set the **Trigger** to **Manual**.




4. Under Calibration Type, select **Import**.

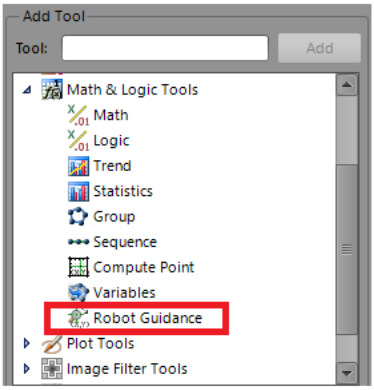



5. In **File Name,** select the .CXD name you entered in the calibration job.

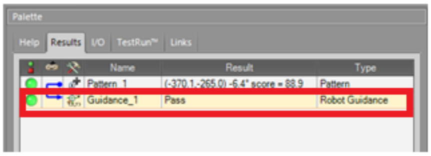



6. Select **Locate Part** and add any preferred tools for locating the part.
7. Perform additional job setup, if applicable.
8. Select **Inspect Part**.

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.




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.

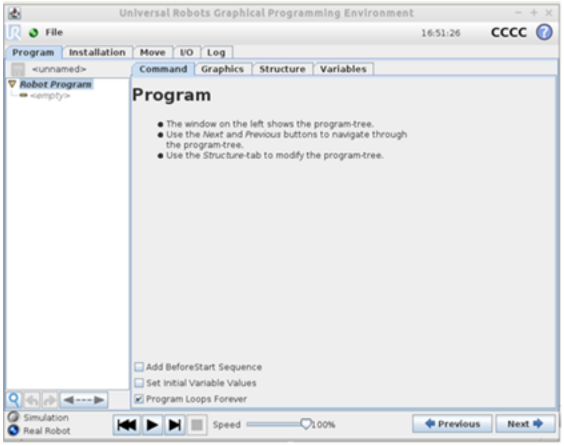
# Set Up the Vision System Pose

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

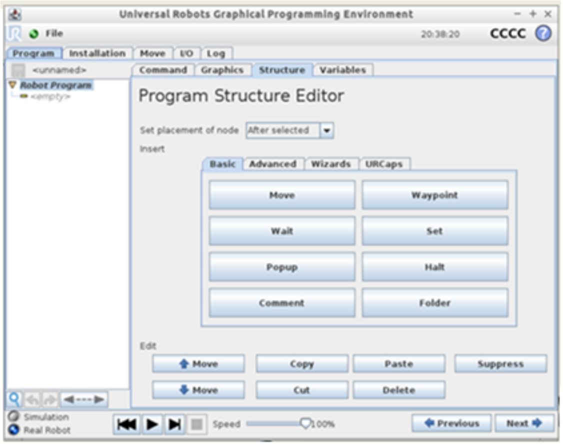
1. Launch the PolyScope program that you created. The main menu displays:


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

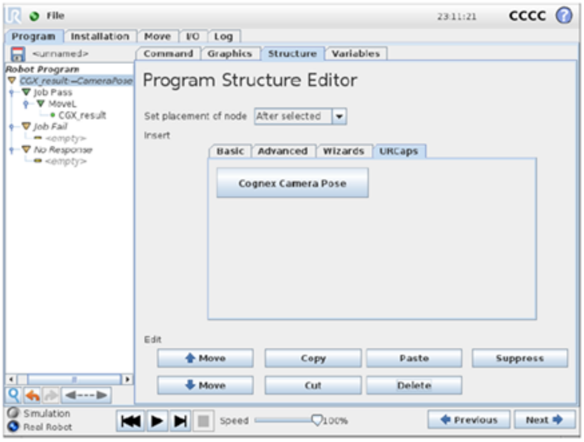

3. Select **Empty Program**.



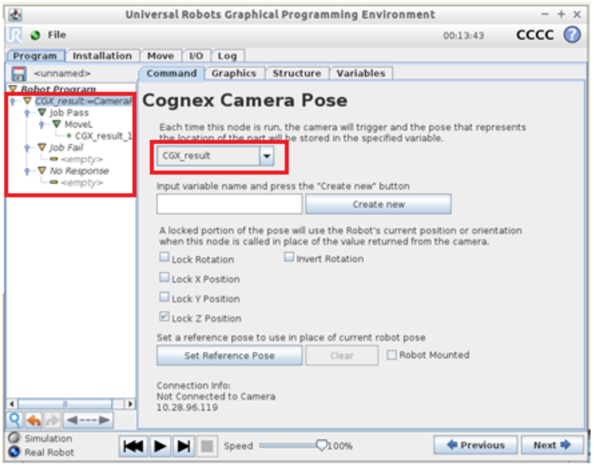
4. Select the **Structure** tab. The Program Structure Editor page displays.




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




6. 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**.



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.

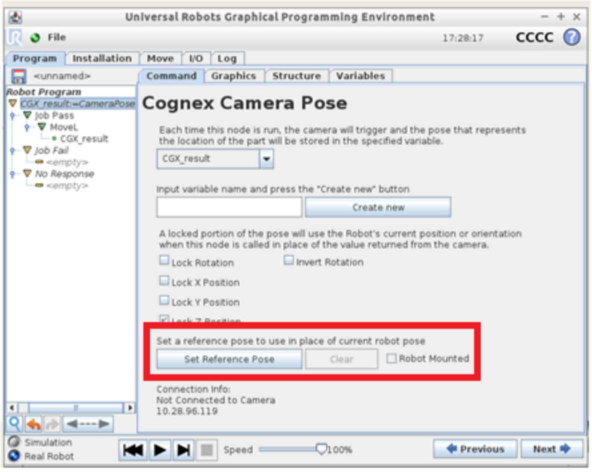
**Note**: If the vision system is mounted to the robot arm, set a reference pose for the robot. Refer to *Set a Reference Pose for the Robot* on page 20.

# Set a Reference Pose for the Robot

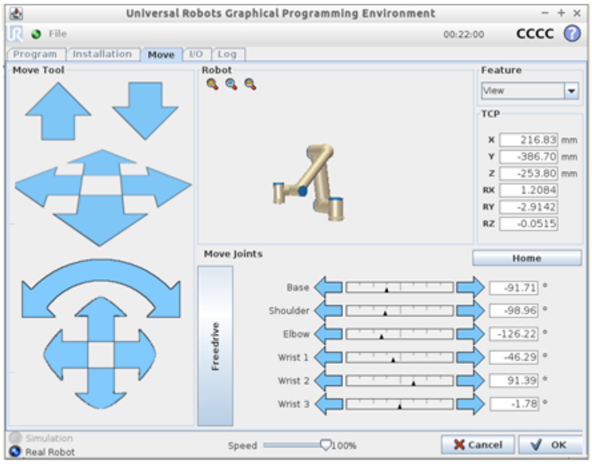
> ⓘ **Note**: This task is required only if the vision system is mounted to the robot arm (optional if the vision system is not mounted to the robot arm).

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

1. 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.

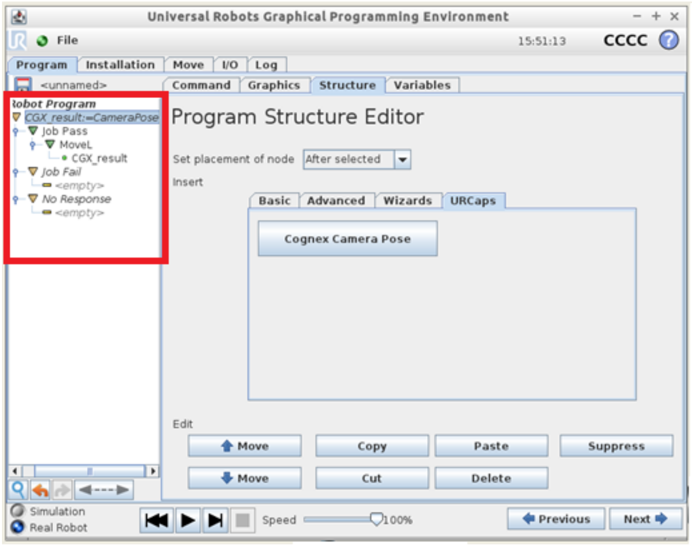



3. Use this tool to move the gripper so that it is aligned with the trained part.
4. When finished, select **OK**.
5. If the vision system is mounted to the robot arm, mark the **Robot Mounted** check box.

   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:




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: