



User Guide: Universal Robots setup for use with Apera Vue robotic vision software

Calibration using fixed frame (eye-to-hand) cameras

Overview

This document assumes you have already installed the UR Cap “apera-3.4.0.urcap file and have already set up your Apera Vue device (version 8.0.0 or above) with working cameras that have been calibrated. Any changes to camera calibration must be followed by a robot calibration. Performing both should take 10 minutes or less once configured. By the end of this document, you should have a successful robot calibration and be ready to run a successful application.

About robot calibration

Apera Vue uses one or more camera pairs to detect objects and estimate their 3D pose. This pose needs to be converted to a pose in the robot’s coordinate system before the robot can pick the object. By calibrating the robot, we calculate a transform from the camera’s coordinate system to the robot’s coordinate system.

Therefore, a new robot calibration is required if there is any change to the cameras relative to the robot. For example, even if the cameras are mounted on a rigid beam and have not moved relative to each other, if the beam itself moves, the cameras have moved relative to the robot.

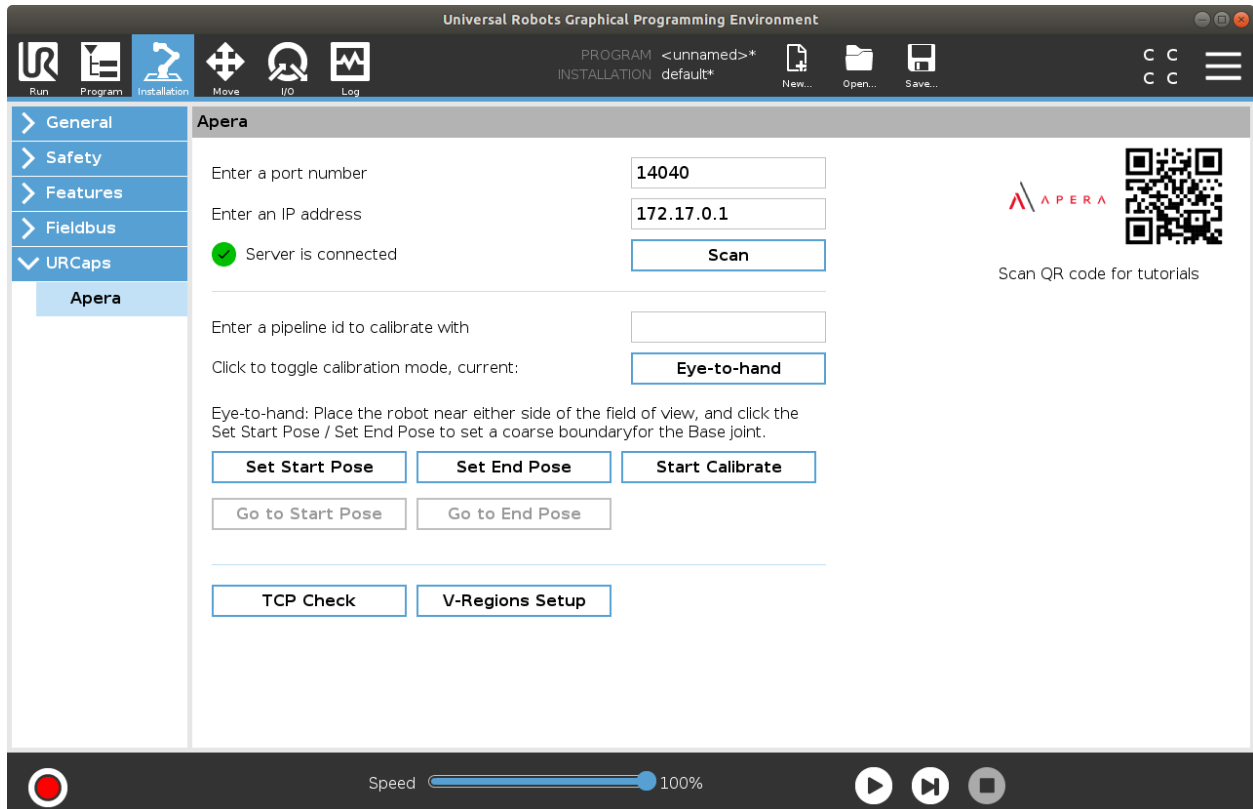
To perform the robot calibration accurately, we take photos of a marker placed on the robot while the robot is in a variety of poses. The marker must be mounted on the gripper or any other structure that is statically affixed to the last robot joint. Using this the system calculates the robot’s base coordinate system (an origin at the base of the robot) relative to the cameras.

When Apera Vue detects an object, it will send the pose of a pick point on the object to the robot with respect to its base coordinate system. Send the robot tool center point (TCP) to this pose, minus an offset for the gripper, to pick the part at the desired translation and orientation.

Server setup

Please click on the Installation tab on the top left corner. On the left side menu, under URCaps, choose Apera.

Figure 1. How to navigate to the Apera interface within URCaps.



Please click on **Scan**. If the Apera Vue server is running in the same network, UR should be able to find it and show its IP. Otherwise, please enter the IP Address of the Apera Vue server in the IP address box.

Please enter the ID of your vision pipeline in the designated box. If you don't know it, please ask Apera AI technical support for help.

Motion configuration

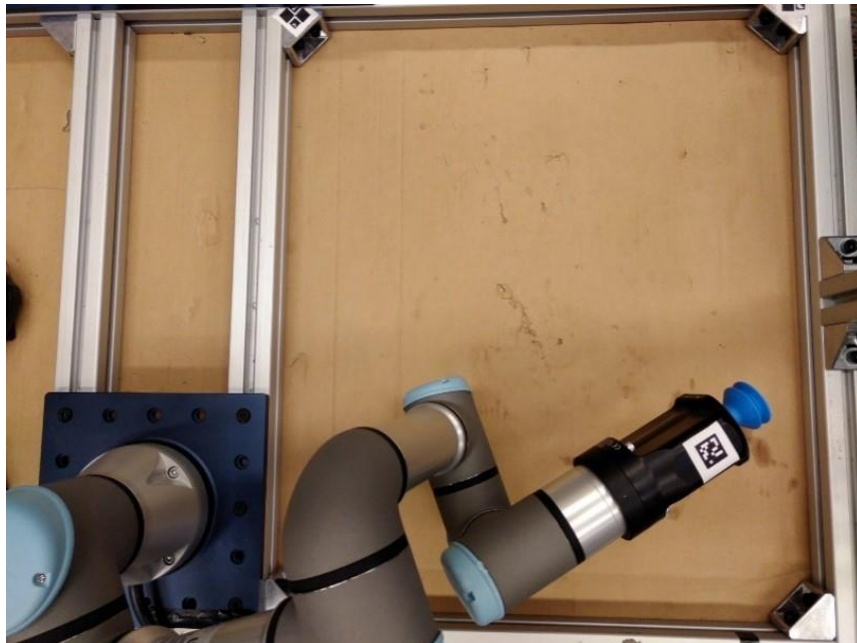
There are two calibration modes. “Eye-to-hand” is where cameras are mounted to look at the robot and the area in which it will operate. Eye-in-hand is where cameras are mounted on the robot’s tool center point (TCP). These two modes can be switched with the toggle button, with the current mode shown on the toggle button. Default mode is eye-to-hand, which is the focus of this document.

For eye-in-hand calibration support, please refer to the related article in our help center.

The calibration procedure will move three joints of the robot: J1, J3, J5. This motion will start at a given position which we need to set first.

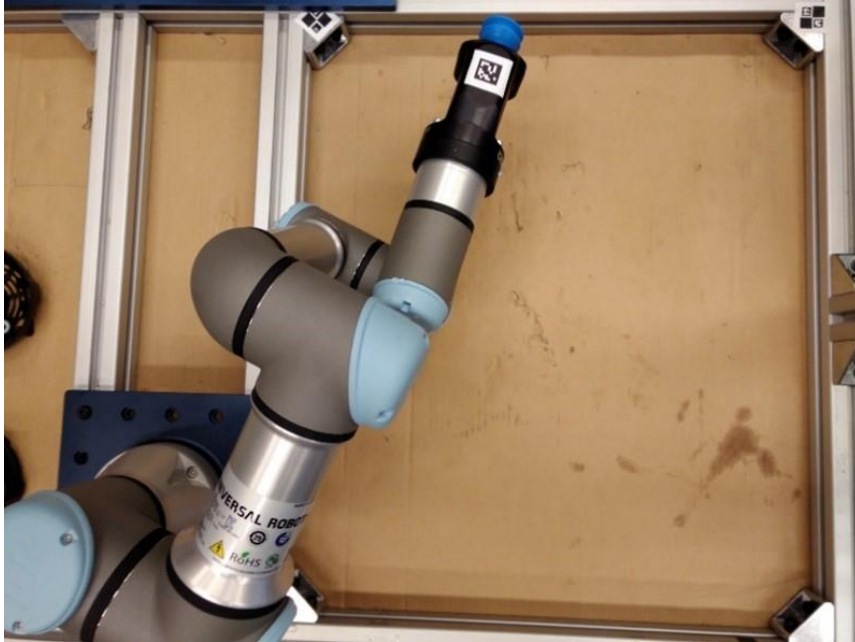
Please move the UR robot to one end of the field of view as shown in Figure 2 below. Please make sure that the marker is visible for the Apera Vue cameras and that the robot will not hit anything on its path.

Figure 2. Moving the UR robot to the edge of its field of view.



Press **Set Start Pose** when you are happy with robot location. Then move the robot to the other end of the field of view as shown in Figure 3 and press **Set End Pose** when you are happy with the location.

Figure 3. Moving the UR robot to the other edge of its field of view.

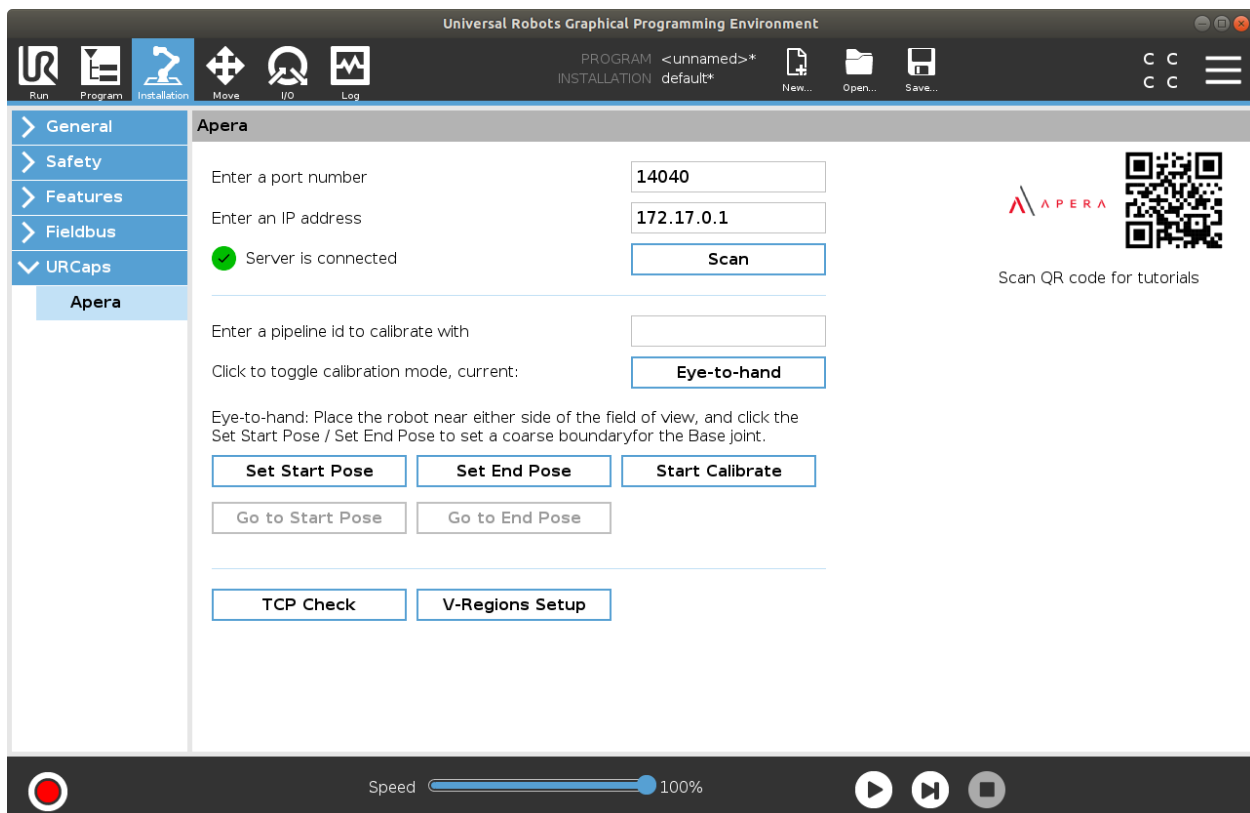


Your robot is ready for calibration.

Running calibration

Click on **Start Calibrate** on the window below to run the calibration.

Figure 4. How to start the calibration process



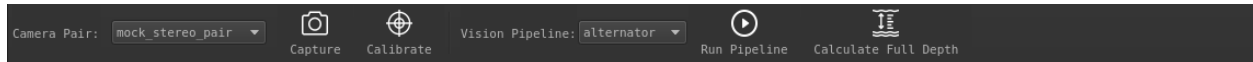
You should be able to see from the Apera Vue UI if it is detecting the marker placed on the robot. If you don't see it in the photos taken by Apera Vue, please adjust your sweep angle settings until you can see the marker as much as possible through the robot motion. This will improve the robot calibration and overall accuracy.

During calibration the robot will move slowly between the start and end poses, moving robot joints. The full sweep will take about a minute. When finished, if calibration was successful, the traffic light indicator light in the bottom-right of the UI should turn green, and status should say **Ready**.

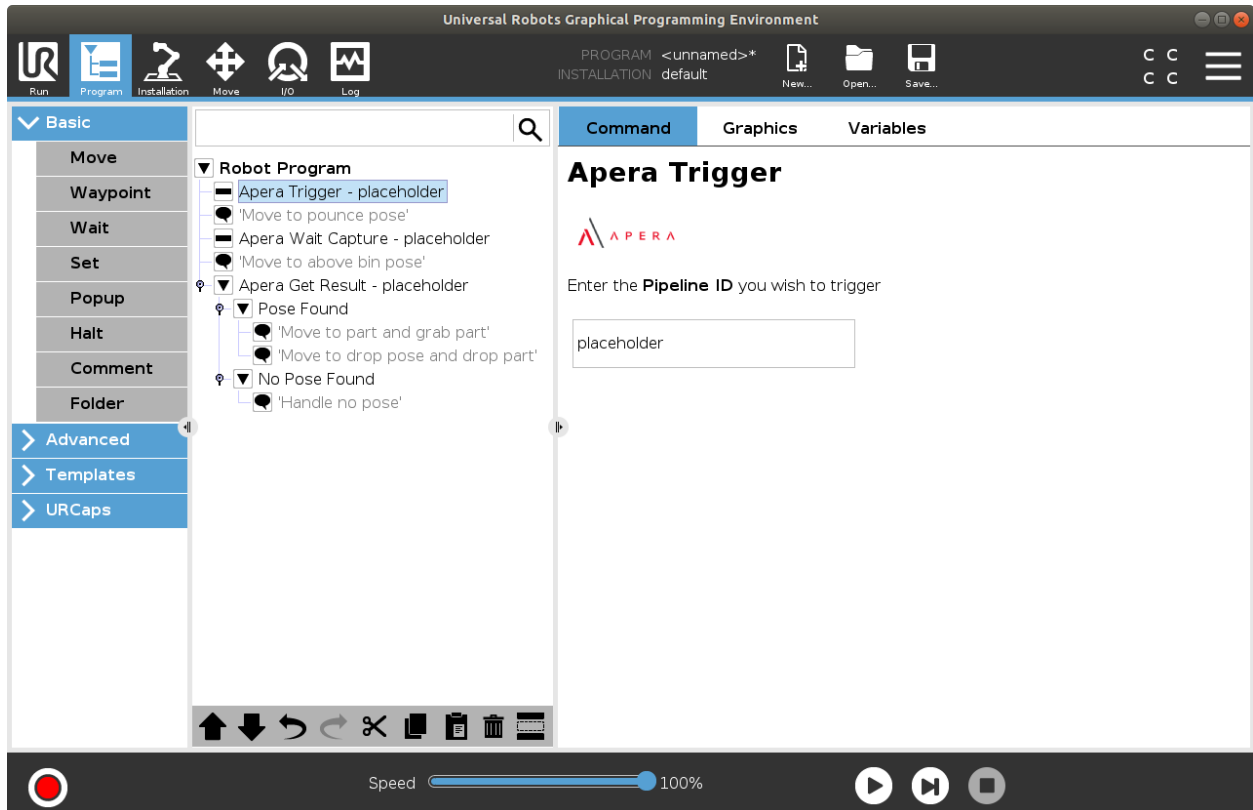
If calibration does not succeed, contact Apera support.

UR programming for normal bin picking

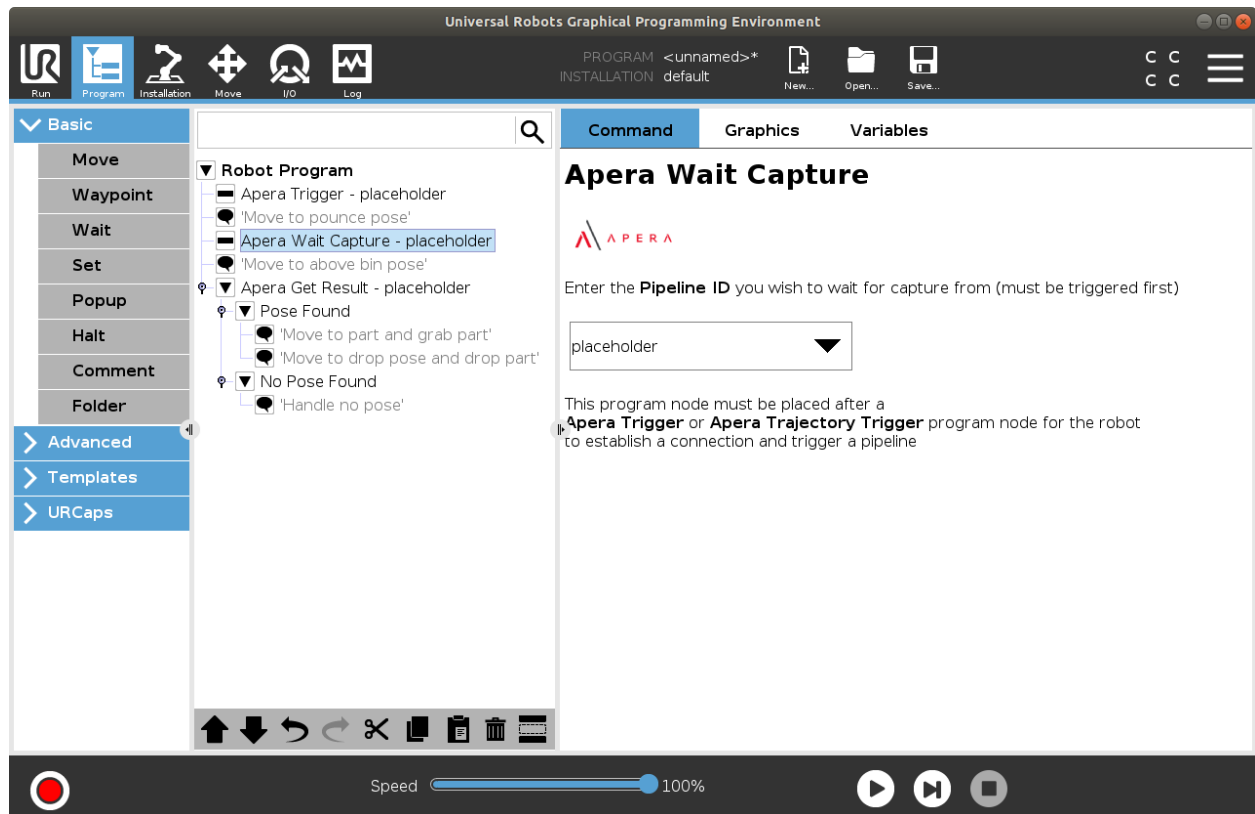
The available Apera Vue pipelines are viewable in the UI drop-down:



Apera Trigger: Select a pipeline ID to trigger.



Apera Wait Capture: Wait for capture to be finished (robot can't block view of the bin before this node is finished)

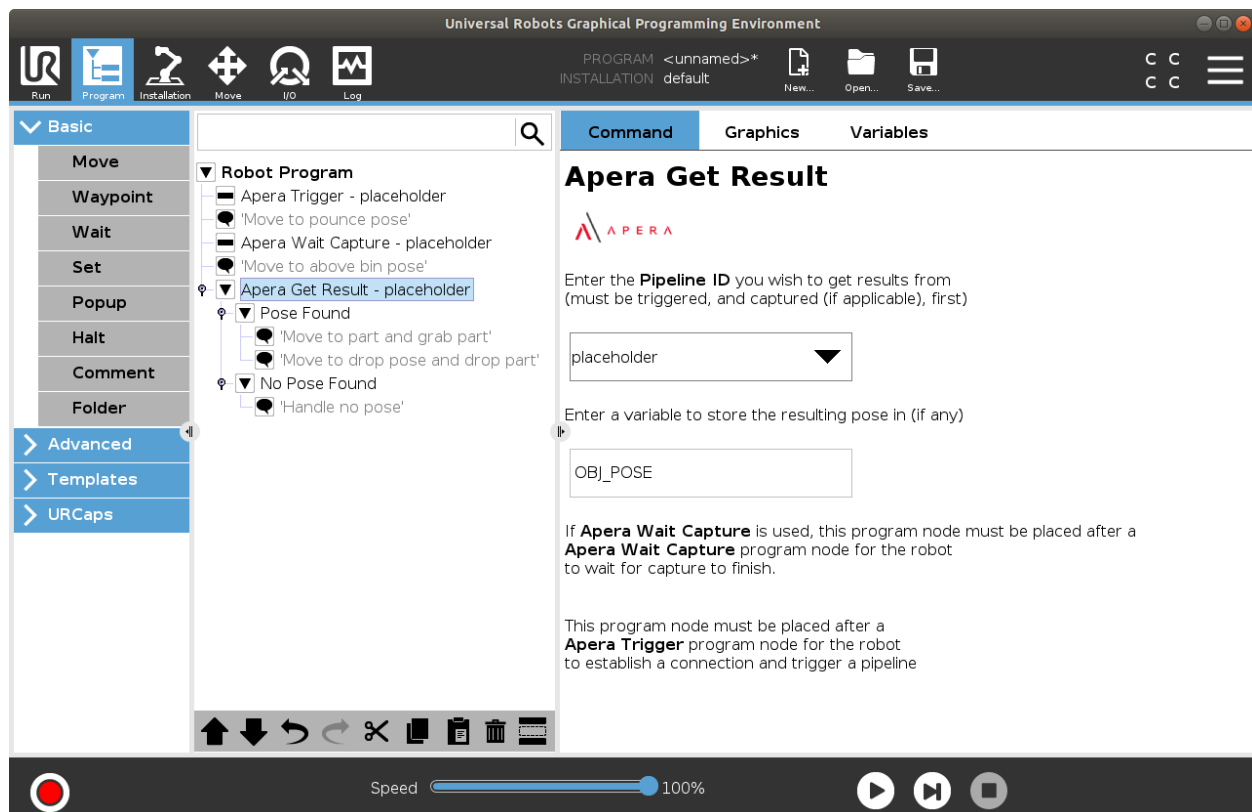


Apera Get Result: Select a variable name for the returned pose.

This node must be preceded by a **Apera Trigger** node with corresponding pipeline ID.

Your custom robot code can be added using the templates provided for the vision system result:

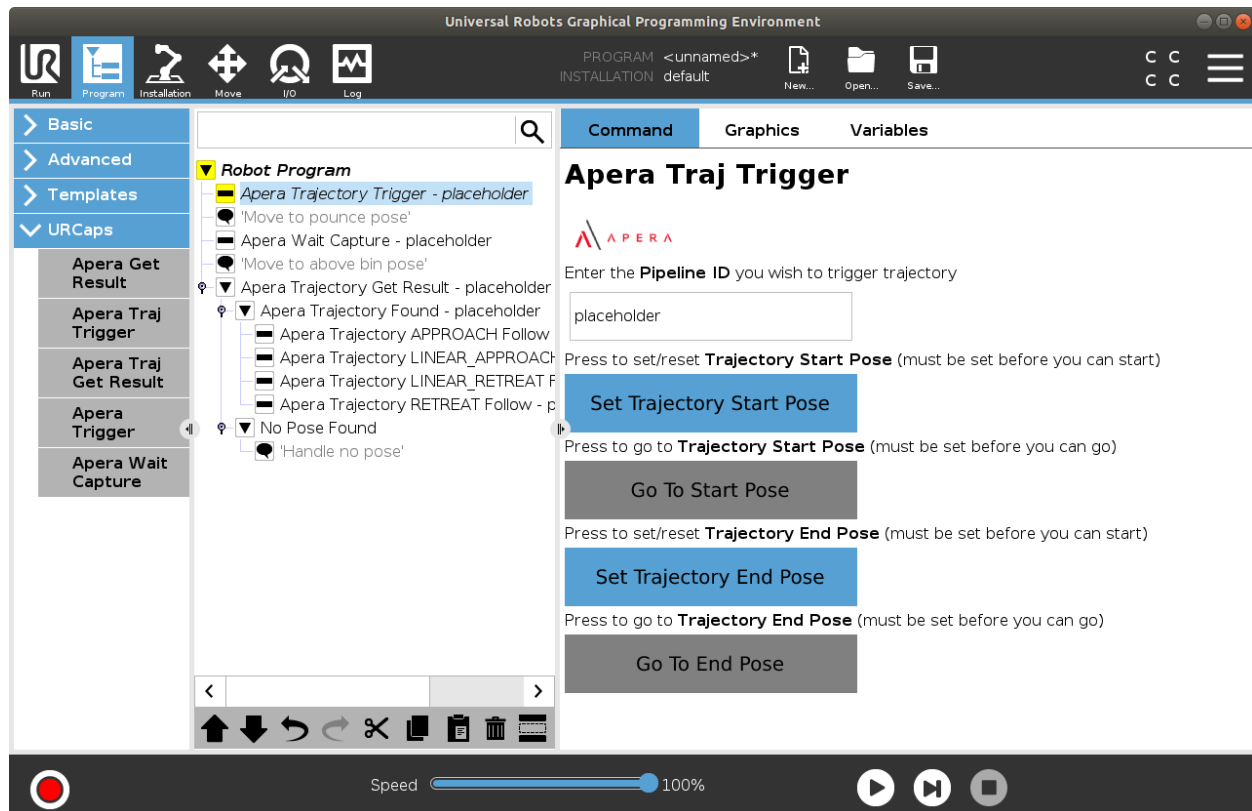
1. Pose Found: Runs once a pose is returned from the vision system
2. No Pose Found: Runs if the vision system returns without a detected pose.



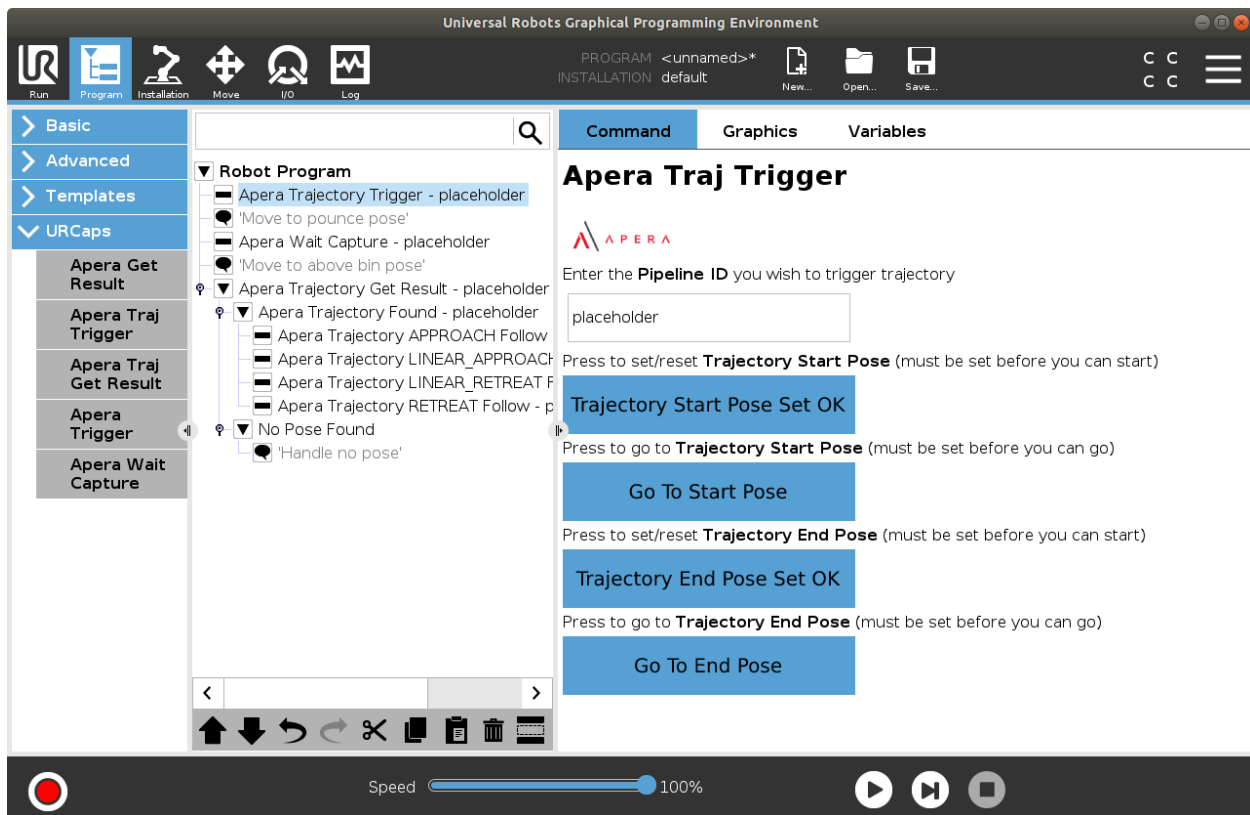
UR programming for trajectory planning (Autopilot)

Apera Trajectory Trigger: Select pipeline ID to trigger.

You have to set trajectory start and end pose. Before the poses are set, the **Go To** buttons will be grey.



You can click **Set** buttons to set start and end pose.

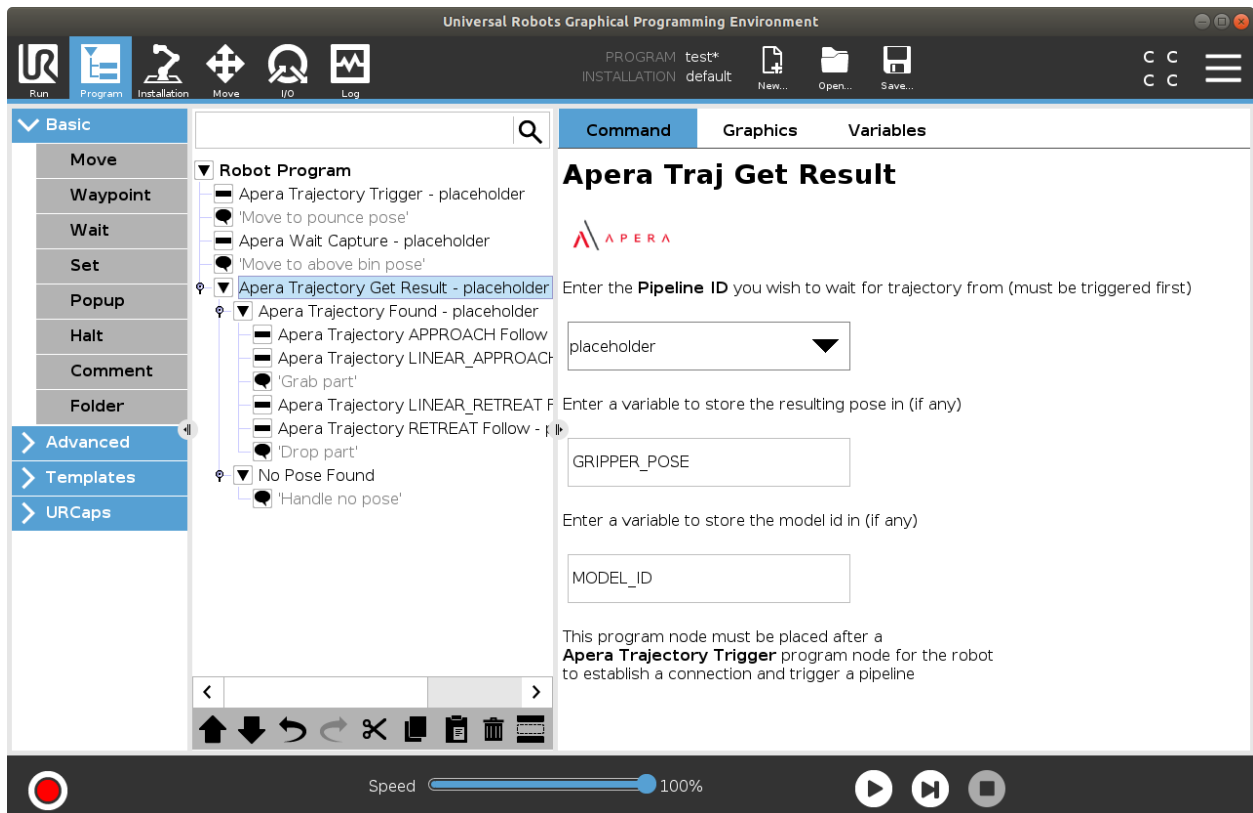


In this sample program, start pose is above bin pose, and end pose to drop pose.

Note: you CAN NOT use Apera Trajectory Trigger with Apera Get Result, and you CAN NOT use Apera Trigger with Apera Trajectory Get Result.

Apera Trajectory Get Result: Sets up follow nodes to go to returned pose.

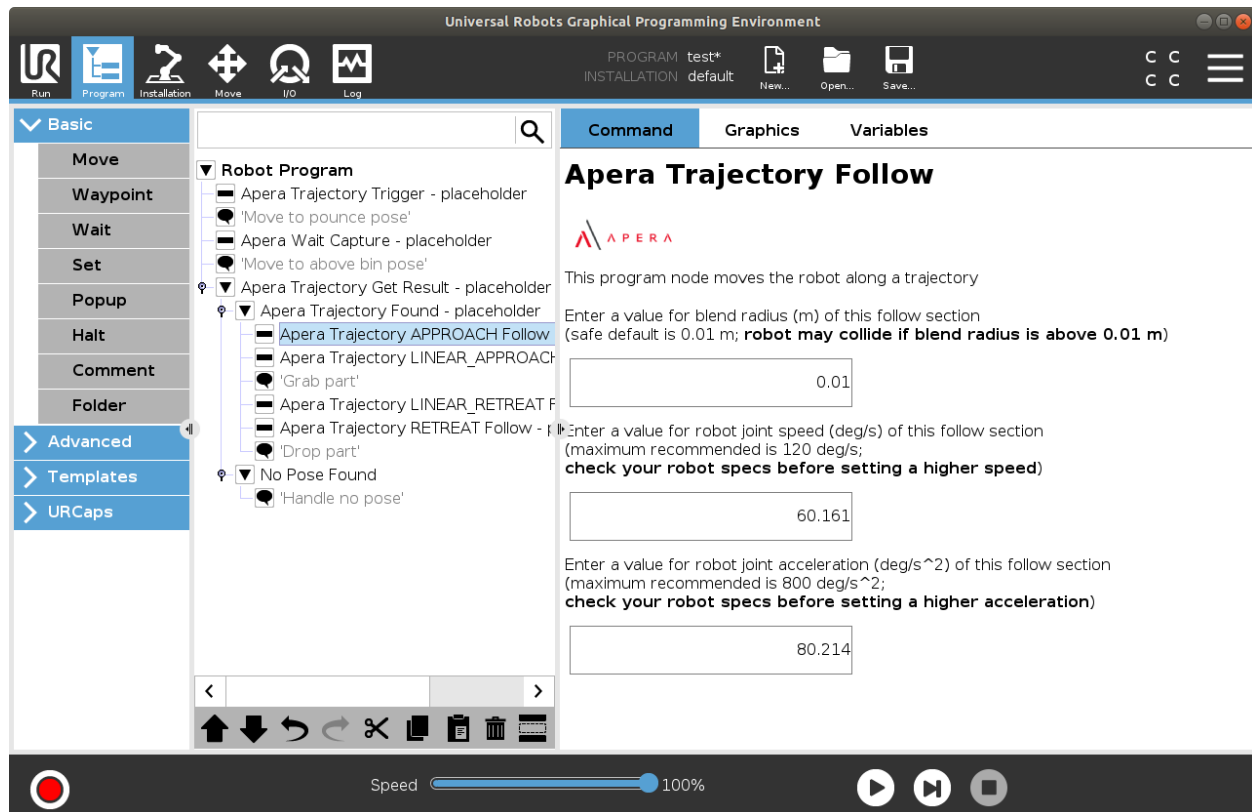
This node must be preceded by a **Apera Trajectory Trigger** node with corresponding pipeline ID.



There are two usable variables you can set the name of:

- Resulting pose: useful if you want custom robot movement (for example, delete linear approach node and use your own MoveL node to go from end of approach section to part)
- Model ID: useful for debug logging purposes

Apera Trajectory Follow: Follows a section of the trajectory.



Planned trajectory is divided into four sections: approach, linear approach, linear retreat, and retreat. For each section, you can set its blend radius, joint speed, and joint acceleration.

If you need technical support

Please contact Apera AI at +1.604.200.4544 and press '2' for support, or you can email support@apera-ai.com. The Apera AI Certified Partner from which you purchased your Vue license may also be able to troubleshoot your system.

Appendix A: Robot calibration troubleshooting

The calibration indicator light can take one of 2 colors:

Green:

- Robot calibration is good. The system is ready for picking.

Red:

- Either:
 - a) The robot is not calibrated.
 - b) The robot calibration failed (error margin was too high to be reliable).
 - c) Robot re-calibration is required ('stale' robot calibration), for example, if the stereo cameras were re-calibrated.

If calibration failed, double-check the following:

- The stereo cameras are well calibrated
- The marker remains in the view of the cameras
- The camera jig and robot base do not shift during calibration
- The motion of the robot covers a wide range of the camera field of view.

If calibration does not succeed, contact Apera AI technical support.