

Linear Conveyor Tracking Work Instruction

April 15, 2025

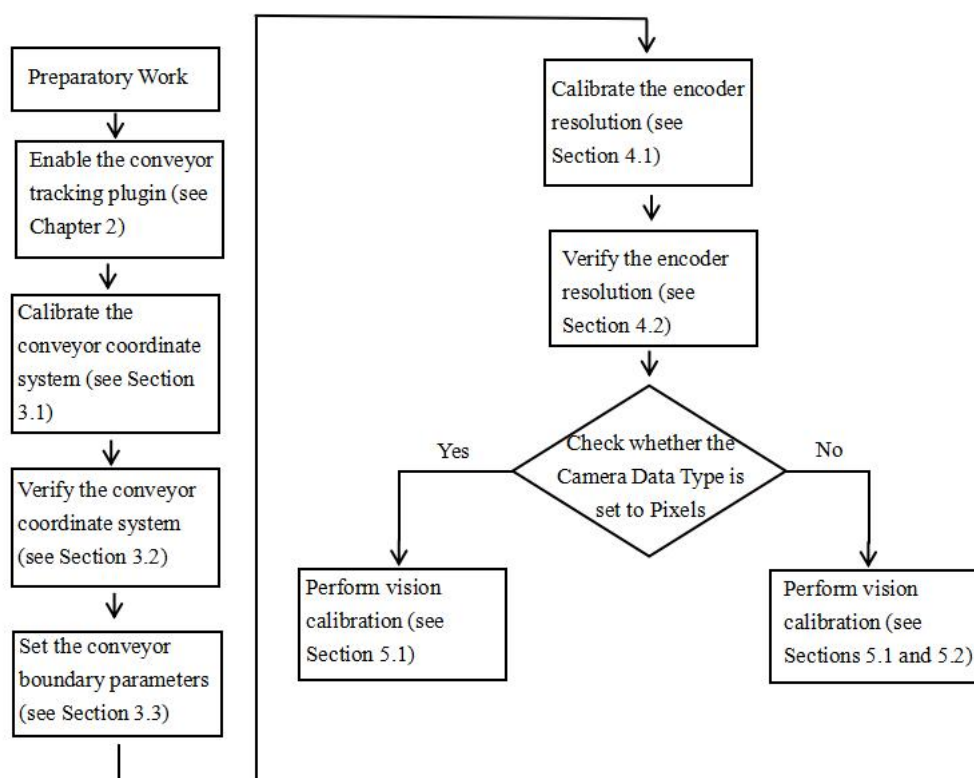
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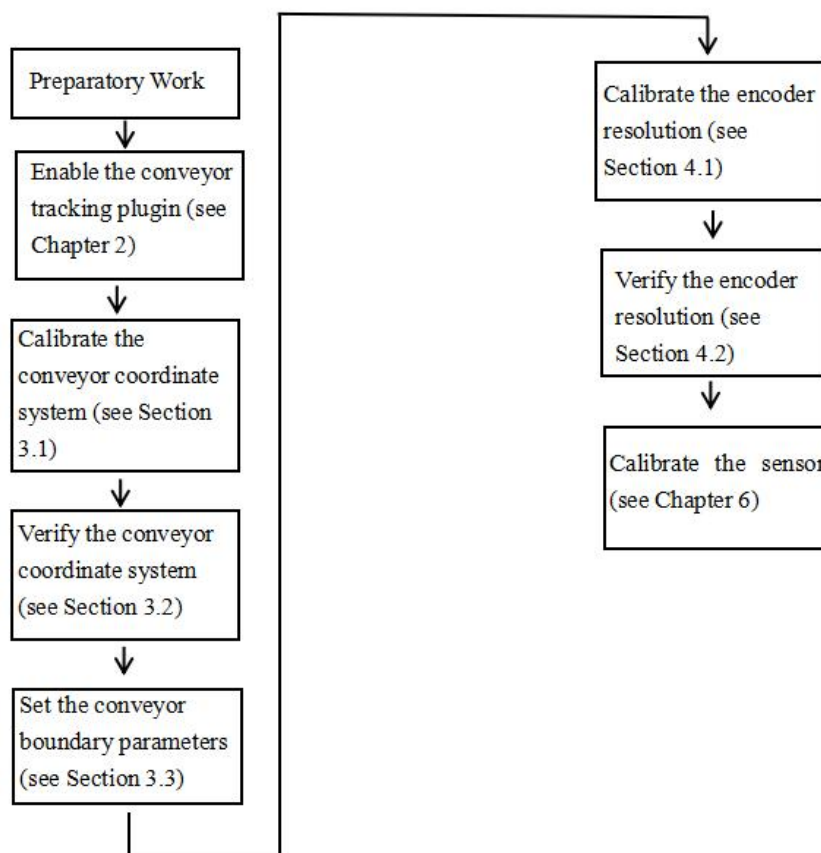
Version	Date	Change Description	Author
V1.0	2021.04.15	Initial version	Han Xiangdong

1. Process Description

1.1 Process when using vision detection



1.2 Process when using sensor detection



1.3 Preparatory work

1. Calibration cone concentricity verification: Install the calibration cone at the end of the robot arm. Place another object with a sharp tip within the robot's reachable workspace. Move the robot arm so that the tip of the calibration cone aligns with the sharp point of the object. On the robot operation interface, switch to the base coordinate system and jog the Rz axis using the jog command within the range of $[-180, 180]$. Observe whether the tip of the calibration cone shows any positional shift relative to the sharp point during Rz rotation. If there is no shift, the concentricity of the calibration cone installation is acceptable; if there is a shift, troubleshooting is required.

2. Enabling the Conveyor Tracking Plugin

On the “Settings → Plugin Extensions” page, check whether there is a “Conveyor” option page. If vision detection is used, a “Vision Calibration” option page is also required, as shown below:



If there is no “Conveyor” and “Vision Calibration” option, go to “Settings → System Settings → Plugin Management”, click the “Upload Plugin” button, and select BeltTracking (conveyor plugin) and CameraCalibration (vision calibration plugin). After successful upload, it will appear as shown below:



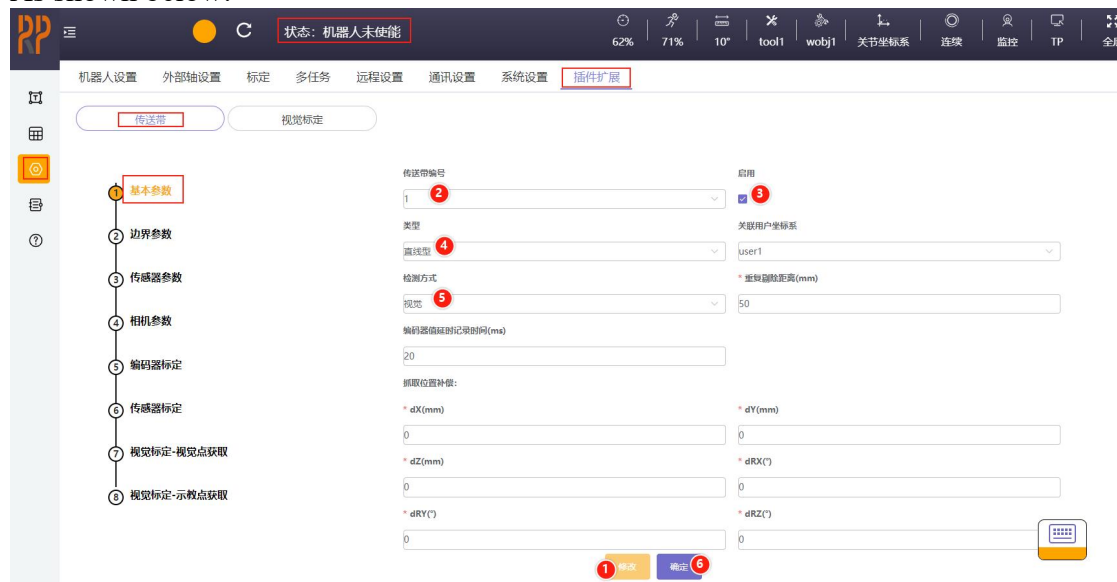
On the “Settings → Plugin Extensions → Conveyor” page, select the “Basic Parameters” tab and configure as follows:

- ① In the enabled state, click “Modify”
- ② Select the conveyor number as needed. Generally, number them in sequence: if there is only one conveyor, the number is 1; if there are two conveyors, the first is No. 1 and the second is No. 2; and so on;
- ③ Click the checkbox under “Enable” to activate the conveyor;
- ④ Select the conveyor “Type” according to the actual configuration: choose “Linear” for a linear conveyor and “Rotary Disc” for a rotary disc conveyor;
- ⑤ Select the “Detection Method” according to the actual situation: choose

“Vision” when using a camera for detection, and choose “Sensor” when using a sensor.

⑥ After editing, click OK;

As shown below:



After completing the above steps, the conveyor tracking function for the selected conveyor number can be configured and used normally.

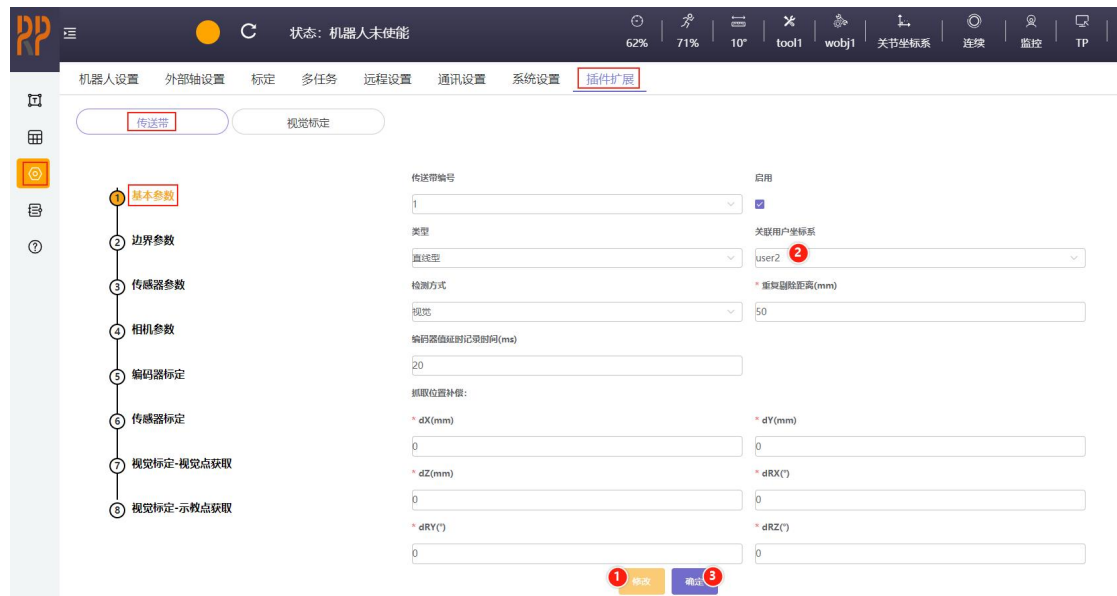
3. Conveyor Coordinate System Calibration

3.1 Calibration

On the “Settings – Plugin Extension – Conveyor” page, select the “Basic Parameters” tab and perform the following operations:

- ① In the enabled state, click “Modify”;
- ② Select “Associated User Coordinate System” according to the actual situation, which will be used as the conveyor coordinate system to be calibrated. In this example, “User2” is selected.
- ③ After modification, click “OK”;

As shown below:

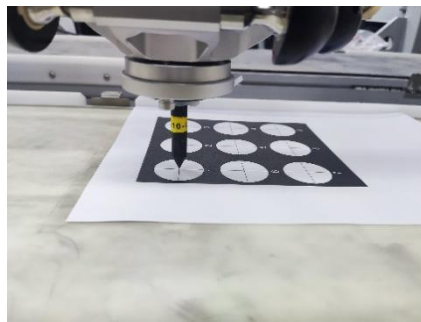
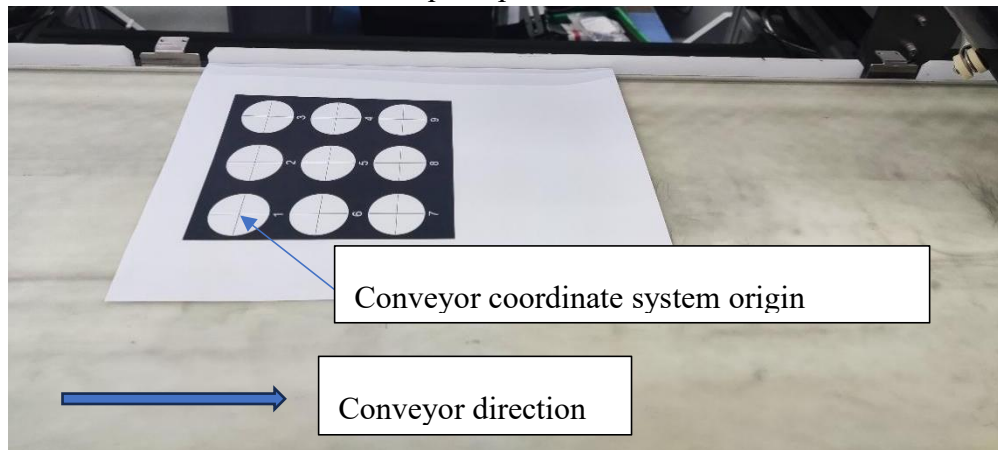


After completing the above steps, the “Associated User Coordinate System” must be calibrated.

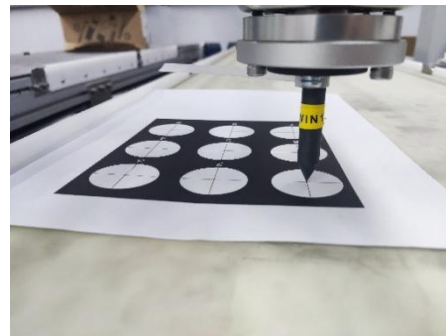
In the above example, User2 is selected, so User2 must be calibrated (if User10 was selected in “Associated User Coordinate System”, then User10 would be calibrated).

Navigate to the “Settings – Calibration – User Coordinate System” page, and follow the steps below:

- ① In the “User Calibration” field, select “User2”;
- ② In the “Calibration Method” field, select “Three-Point Method”;
- ③ Select “tool1 - wobj1 - base coordinate system”;
- ④ Place the calibration plate on the conveyor at an appropriate position. To prevent slipping, stick the calibration plate onto the conveyor. Choose a feature point on the plate as the origin of the user coordinate system. Operate the robot so that the calibration cone touches this feature point. Ensure the cone tip remains close to the calibration plate, as shown in the figure below. Use the same standard for subsequent point selections. Click “Get Point 1”;

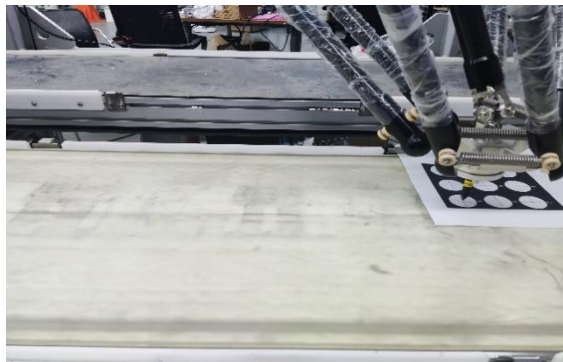


Front view

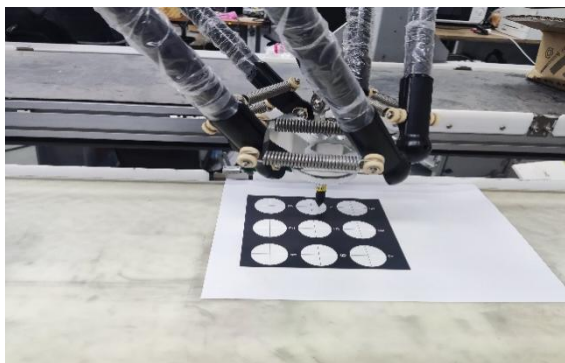


Side view

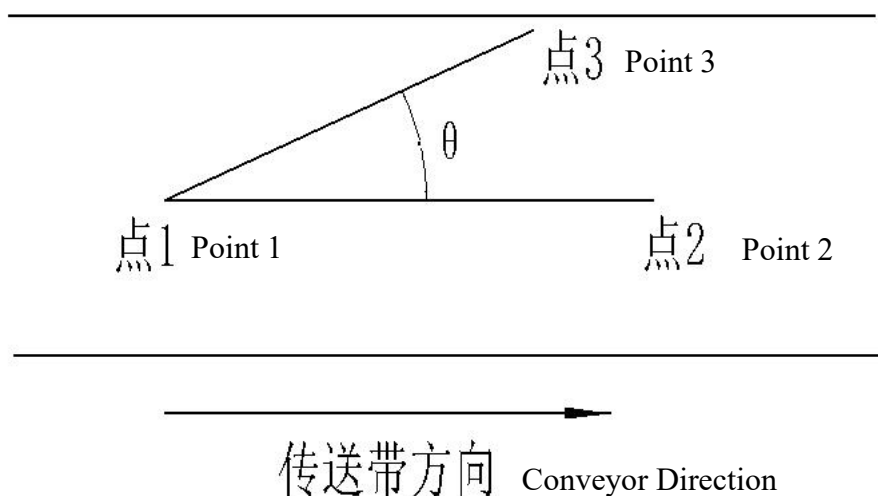
- ⑤ Raise the calibration cone slightly by operating the robot, then start the conveyor to move the calibration plate over a long distance (at least 50% of the working range). Operate the robot to make the calibration cone touch the same feature point again, as shown in the figure below, and click “Get Point 2”.



- ⑥ According to the right-hand rule ($Z+$ direction is consistent with the robot base coordinate system; for non-inverted machines $Z+$ points upward; $X+$ is the conveyor flow direction), determine the direction of $Y+$. After confirming the direction, jog the robot so that the calibration cone touches a point in the $X+Y+$ plane, as shown below, and click “Get Point 3”;

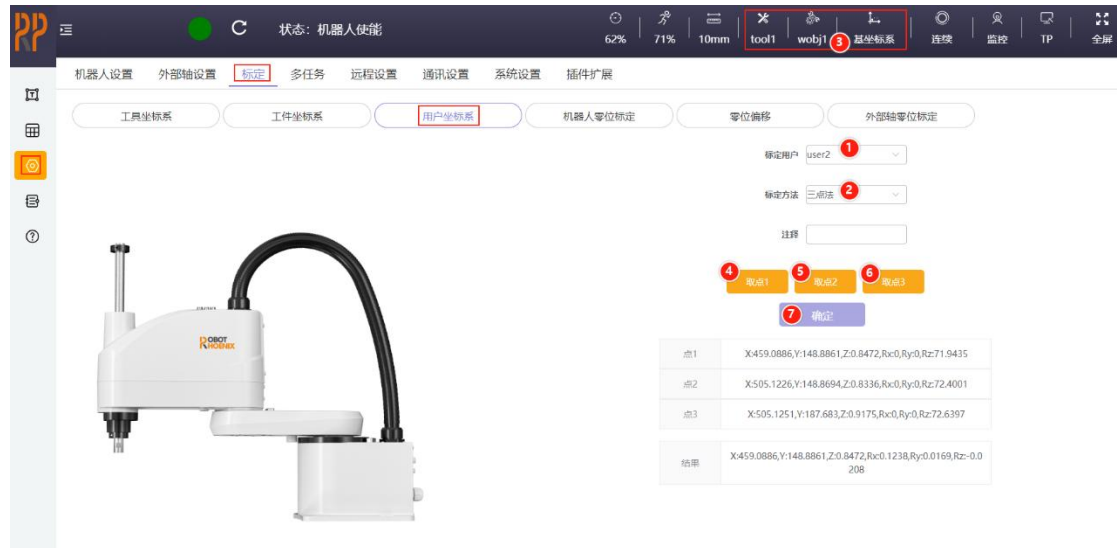


Note: When taking Point 3, ensure that the angle θ between the line from Point 1 to Point 2 and the line from Point 1 to Point 3 is greater than 10° , as shown in the figure below.



- ⑦ Click “OK” to complete the calibration;

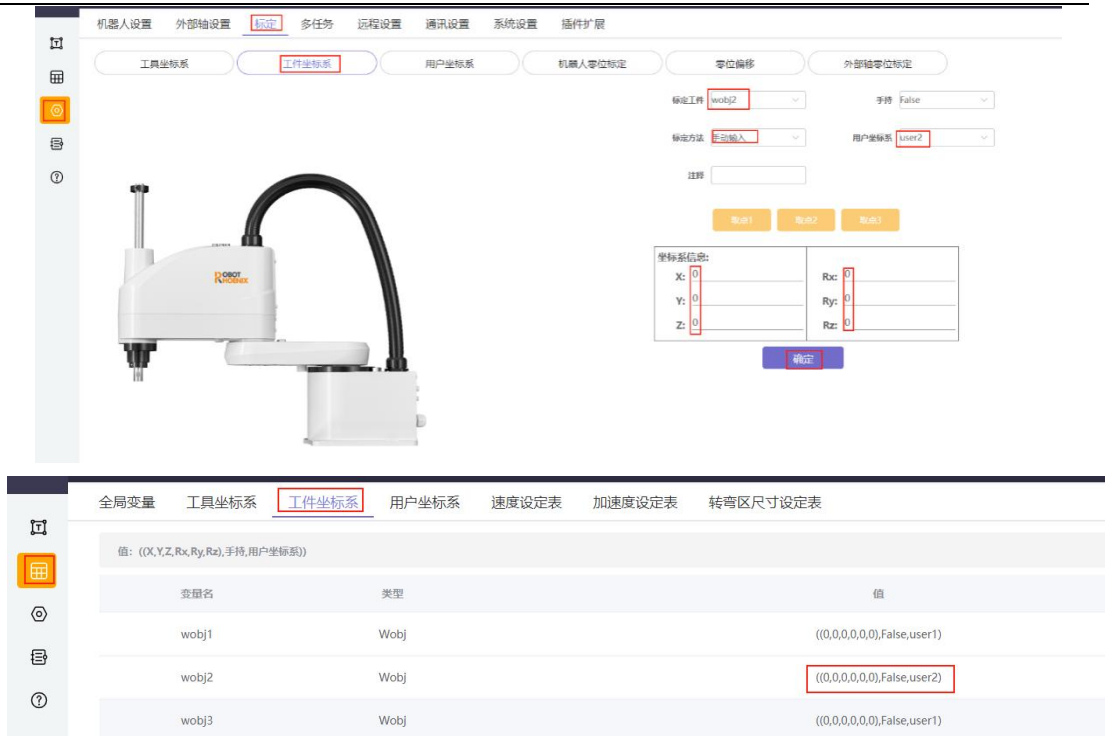
The overall procedure is shown in the diagram below:



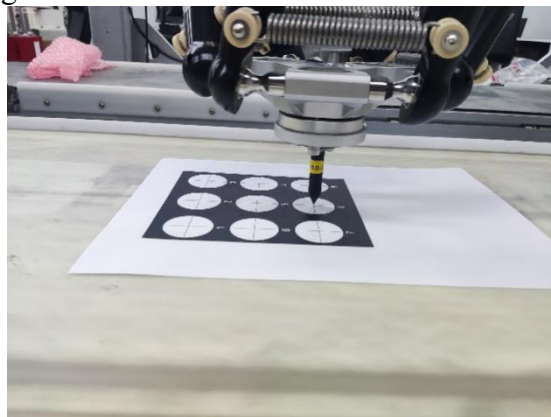
3.2 Verification

To verify the correctness of the user coordinate system calibrated above, follow these steps:

- ① Create a work object coordinate system. In this example, wobj2 is created. On the “Settings – Calibration – Work Object Coordinate System” page, select “wobj2” under “Calibrate Work Object”. Set the Calibration Method to Manual Input. Select the user coordinate system calibrated in Section 3.1 (in this example, User2). Set all values for X, Y, Z, Rx, Ry, and Rz in the coordinate system information to 0, then click “OK”. After successful calibration, the information for wobj2 will be ((0,0,0,0,0,0), false, User2), as shown in the figure below.

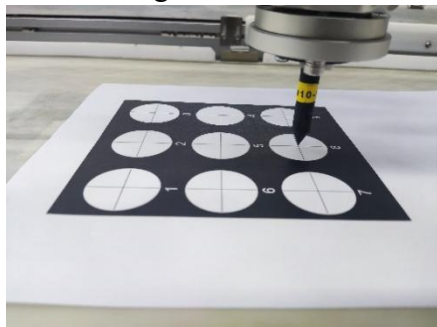


- ② Select “tool1 – wobj2 – User Coordinate System”.
- ③ Place the calibration plate on the conveyor within the robot’s workspace. Jog the robot so that the calibration cone points to a selected feature point, as shown in the figure below.

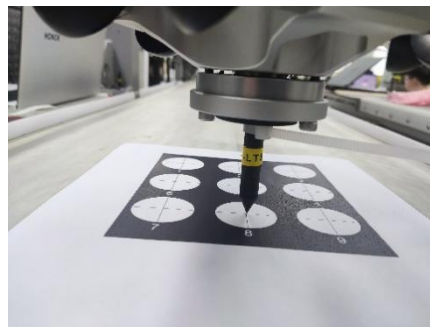


- ④ Raise the calibration cone slightly by operating the robot. Start the conveyor so that the calibration plate moves a distance greater than 50% of the robot’s workspace. Jog the robot along X+ until the cone is near the feature point, then jog along Z- to bring the tip close to the calibration plate. Fine-tune along X- or X+ as needed (do not jog along Y+/Y- during this step). Observe whether the tip of the calibration cone passes through the feature point. The

minimum distance to the feature point should be within ± 0.5 mm, as shown in the figures below.



Front view

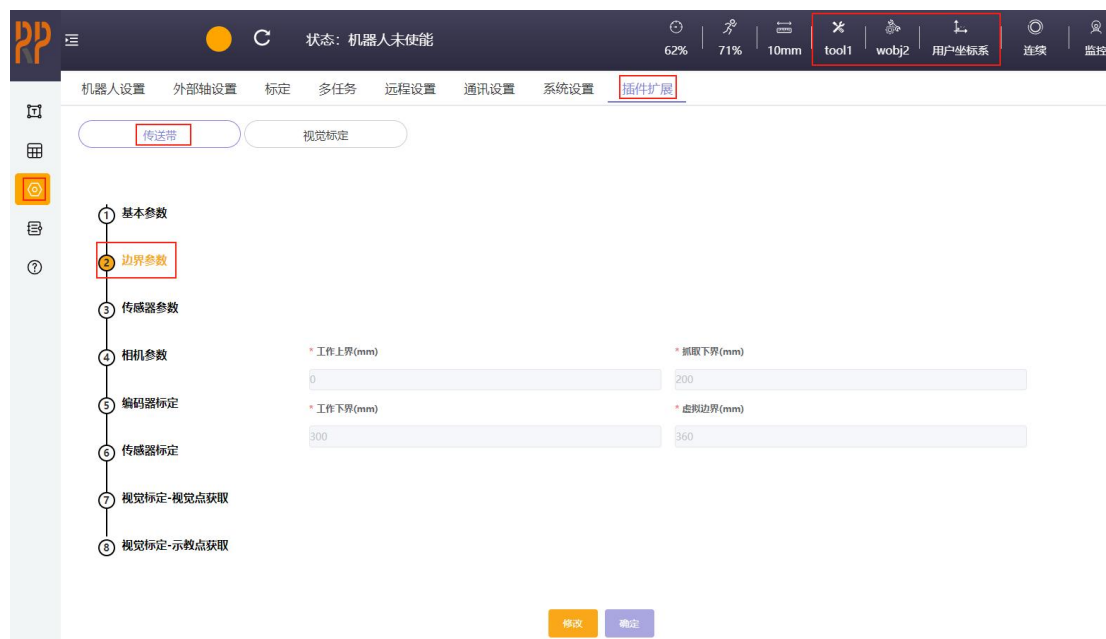


Side view

3.3 Setting boundary parameters

After completing Sections 3.1 and 3.2 and verifying that the conveyor coordinate system calibration is correct, perform the initial boundary parameter setup. (These parameters may need adjustment later based on conveyor and robot speeds.) Follow these steps:

- ① Select “tool1 – wobj2 – User Coordinate System”. Switch to the “Settings – Plugin Extension – Conveyor – Boundary Parameters” interface, as shown in the figure below.



- ② Position the robot's calibration cone above the conveyor. Jog along X- until it reaches the limit of the workspace on that side. Note the X value in the jog interface or "Monitor – Position" interface (denoted as x1). Enable editing, click "Modify", and set "Upper Work Limit" to the nearest integer greater than x1. Click "OK" after modification, as shown in the figure below.

* 工作上限(mm)	* 抓取下限(mm)
0	250
* 工作下限(mm)	* 虚拟边界(mm)
300	350



- ③ Jog the robot along the X+ direction until it reaches the limit of the workspace on that side. At this point, the X value in the jog interface or in the "Monitor – Position" interface is x2. Eable, click "Modify", and set the "Lower Work Limit" to the value obtained by x2 minus 20. After making the modification, click "OK", as shown in the figure below.

* 工作上限(mm)	* 抓取下限(mm)
0	250
* 工作下限(mm)	* 虚拟边界(mm)
300	350



- ④ Click "Modify", set "Lower Pick Limit" to Lower Work Limit – 50, and "Virtual Boundary" to Lower Work Limit + 50. Click "OK" after modification, as shown in the figure below.

* 工作上限(mm)	* 抓取下限(mm)
0	250
* 工作下限(mm)	* 虚拟边界(mm)
300	350



Note: The above describes the general method for setting the upper and lower work limits. The determination of the upper and lower work limits should be based on the actual situation, such as potential interference with on-site racks or other obstacles, and should be set accordingly.

4. Encoder Resolution Calibration

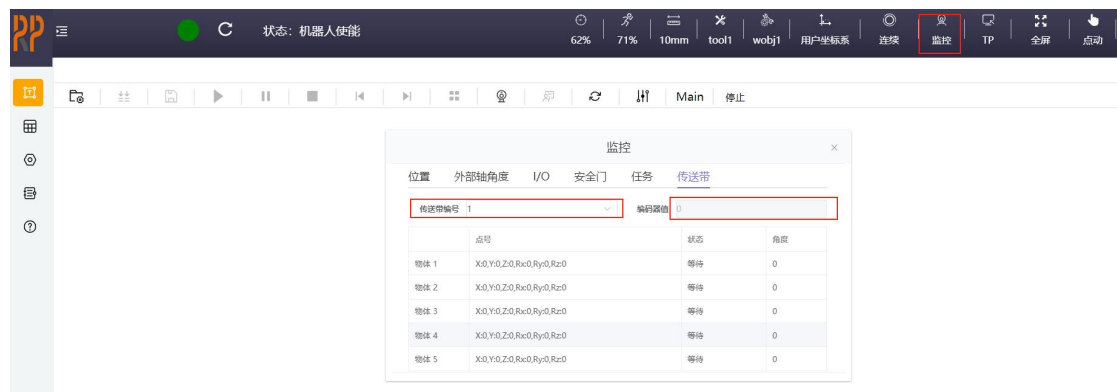
This step has no sequential dependency with the conveyor coordinate system calibration in Chapter 3.

For cases where the pulley is equipped with an encoder, before performing encoder resolution calibration, it is necessary to ensure that, when the conveyor is running normally, there is sufficient pressing force between the pulley and the conveyor belt to prevent slippage during operation.

4.1 Calibration

Encoder calibration follows the steps below:

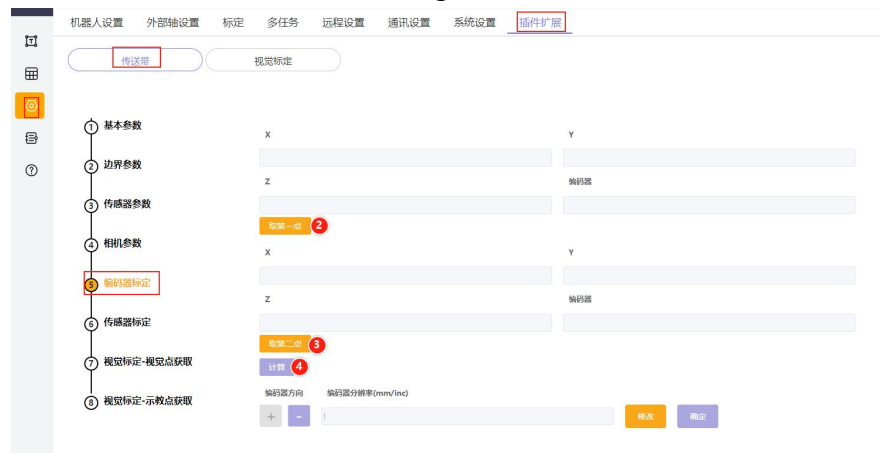
① Start the conveyor and let it run. On the “Monitoring” page, select the corresponding conveyor number and check whether the encoder value changes continuously and monotonically, as shown in the figure below. If yes, proceed to the next steps; if not, first troubleshoot issues such as hardware wiring.



② On the “Settings – Plugin Extension – Conveyor – Encoder Calibration” page, place the calibration plate on the conveyor near the camera side and within the robot’s workspace. Stick the calibration plate onto the conveyor. Jog the robot so that the calibration cone touches the feature point, then click “Get First Point”.
(Note: Before clicking “Get First Point”, switch the tool and work object to tool1 and wobj1.)

- ③ Jog the robot upward for a short distance, then start the conveyor to move the calibration plate a certain distance (more than 50% of the robot's workspace). Stop the conveyor, jog the robot so that the calibration cone touches the feature point again, and click "Get Second Point". (Note: Before clicking "Get Second Point", switch the tool and work object to tool1 and wobj1.)
- ④ Click "Calculate" to obtain the encoder resolution and encoder direction.

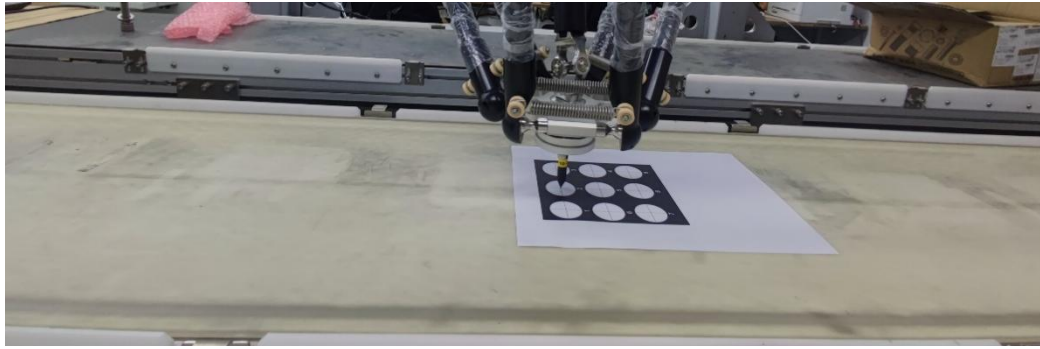
Steps ②, ③, and ④ are shown in the figure below.



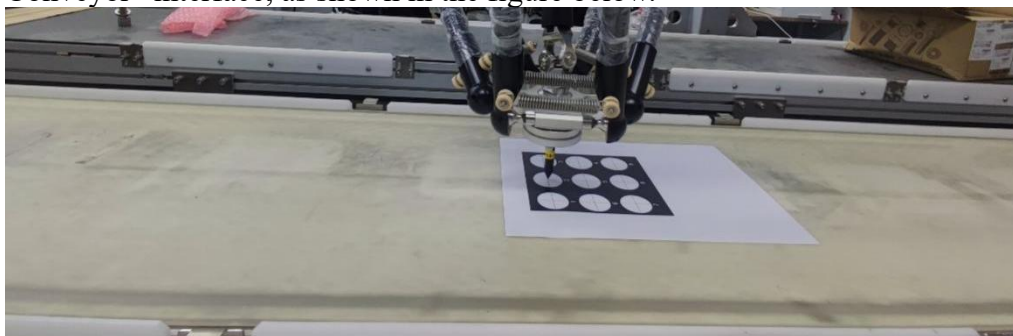
4.2 Verification

The verification of the encoder calibration results follows the steps below:

- ① In the "Editor – File Management" interface, click "Operate – New Program" to create a new program.
- ② Attach the calibration plate near the upper boundary of the conveyor belt. Use jog operation to move the robot so that the calibration tip touches a feature point on the calibration plate. In the editor's variable declaration area, declare a RobotTarget variable p1. Place the mouse cursor on this line and click the "Teach" button to record the robot position. In the program, declare a Double variable e1 in the editor's variable declaration area and set its initial value to the encoder value of the corresponding conveyor number from the "Monitoring-Conveyor" interface, as shown in the figure below.



③ Use jog operation to move the robot upward by a certain distance. Start the conveyor to drive the calibration plate to approximately the middle position between the upper and lower workspace limits, then stop the conveyor. Use jog operation to move the robot so that the calibration tip touches a feature point on the calibration plate. In the editor's variable declaration area, declare a RobotTarget variable p2. Place the mouse cursor on this line and click the “Teach” button to record the robot position. In the program, declare a Double variable e2 in the editor's variable declaration area and set its initial value to the encoder value of the corresponding conveyor number from the “Monitoring – Conveyor” interface, as shown in the figure below.



```

1 Program CalDistance
2 Var
3 p1:RobotTarget:=((-362.5317,-205.9424,-995.3698,0,0,-0.15),(-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
4 e1:Double:=733119;
5
6 p2:RobotTarget:=((-106.299,-328.6362,-997.4346,0,0,-0.15),(-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
7 e2:Double:=744450;
8
9 EndVar

```

④ Use jog operation to move the robot upward by a certain distance. Start the conveyor to drive the calibration plate to a position near the lower workspace limit, then stop the conveyor. Use jog operation to move the robot so that the calibration tip touches a feature point on the calibration plate. In the editor's variable declaration area, declare a RobotTarget variable p3. Place the mouse cursor on this line and click the “Teach  ” button to record the robot position. In the program, declare a Double variable e3 in the editor's variable declaration area and set its initial value to the encoder value of the corresponding conveyor number from the “Monitoring – Conveyor” interface, as shown in the figure below.

```

1 Program CalDistance
2 Var
3 p1:RobotTarget:=((-362.5317,-205.9424,-995.3698,0,0,-0.15),(-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
4 e1:Double:=733119;
5
6 p2:RobotTarget:=((-106.299,-328.6362,-997.4346,0,0,-0.15),(-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
7 e2:Double:=744450;
8
9 p3:RobotTarget:=((194.8466,-472.7863,-998.1211,0,0,-0.15),(-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
10 e3:Double:=757802;
11 EndVar
12

```

⑤ Write the program as shown in the figure below. Assign the initial value of

编码器分辨率(mm/inc)

ratio to “Encoder Resolution

编码器方向

initial value of dir according to “Encoder Direction  ”determined during calibration. The purple box indicates the calibrated direction: when it is “+”, dir = 1.0; when it is “-”, dir = -1.0. Click “Step Run,” and when the cursor reaches line 8, use “Variable Monitoring  ” to check the values of delta1 and delta2.

Under normal conditions, both delta1 and delta2 should be within 1 mm, and the absolute difference between delta1 and delta2 should be less than 0.15 mm, as shown in the figure below.



状态: 机器人使能
78% 14% 0.1mm

编辑器

CalDistance x

```

1 Program CalDistance
2 Var
3 ratio:Double:=0.025012443443958077;
4 dir:Double:=1.0;
5
6 p1:RobotTarget:=((-362.5317,-205.9424,-995.3698,0,0,-0.15),(-1,-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
7 e1:Double:=733119;
8
9 p2:RobotTarget:=((-106.299,-328.6362,-997.4346,0,0,-0.15),(-1,-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
10 e2:Double:=744450;
11
12 p3:RobotTarget:=((-194.8466,-472.7863,-998.1211,0,0,-0.15),(-1,-1,-1,-1,0,0,0,0),(0,0,0,0,0,0),tool1,wobj1);
13 e3:Double:=757802;
14
15 L1:Double;
16 L2:Double;
17 L1_:Double;
18 L2_:Double;
19 delta1:Double;
20 delta2:Double;
21 EndVar
22
23
24 L1:=Sqrt(Pow((p2.pose.x-p1.pose.x),2)+Pow((p2.pose.y-p1.pose.y),2)+Pow((p2.pose.z-p1.pose.z),2));
25 L2:=Sqrt(Pow((p3.pose.x-p1.pose.x),2)+Pow((p3.pose.y-p1.pose.y),2)+Pow((p3.pose.z-p1.pose.z),2));
26
27 L1_:=(e2-e1)*ratio*dir;
28 L2_:=(e3-e1)*ratio*dir;
29
30 delta1:=Abs(L1-L1_);
31 delta2:=Abs(L2-L2_);
          
```

变量监控

局部变量
全局变量

搜索: 显示全部

变量名	类型	值	注释	操作
L2	Double	617.9675		
L1_	Double	283.275		
L2_	Double	617.075		
delta1	Double	0.8257		
delta2	Double	0.8925		

Note: When teaching the above three positions, ensure that tool1 and wobj1 are selected.

5. Vision Calibration

When the detection method in “Settings-Plug-in Extension -Conveyor-Basic Parameters” is set to “Vision,” vision calibration is required. Vision calibration can only be performed after completing the calibrations in Chapters 3 and 4.

5.1 Calibration

Vision calibration follows the steps below:

① In the “Settings – Plug-in Extension – Conveyor – Camera Parameters” interface, set the “Camera Trigger DO” to match the actual camera hardware wiring. Set the “Camera Data Type”: if the vision calibration is performed by the robot system, select “Pixel,” where the vision system sends the pixel coordinates of the identified point; if the calibration is performed by the vision system, refer to Section 5.3. The “Vision Coordinate System Number” usually corresponds to the conveyor number, representing the storage location of the calibration results, as shown in the figure below. After configuration, change the camera trigger mode to hardware trigger. In the “Monitoring – IO – DO” interface, manually set the corresponding DO of the configured “Camera Trigger DO” to True, and check whether the camera takes a photo. Repeat several false-true cycles to verify that the photo trigger works correctly.

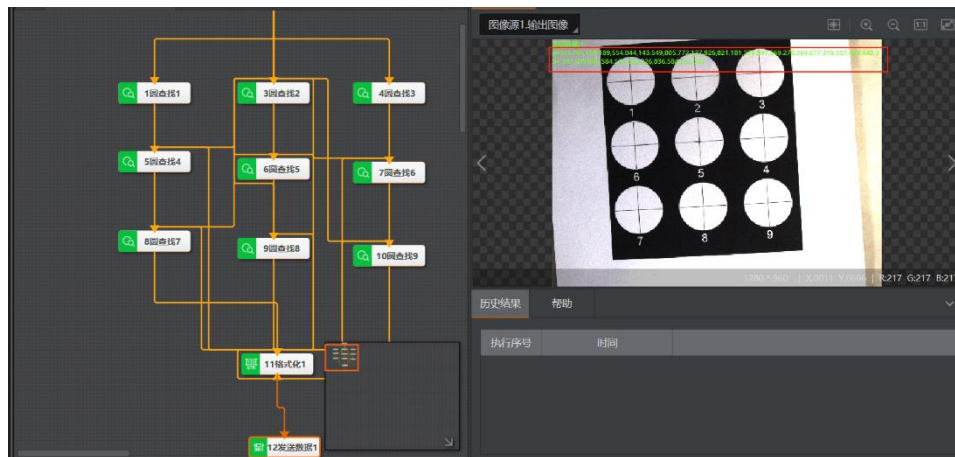


② Place the calibration plate within the camera's field of view and attach it to the conveyor belt, ensuring that the distance from its top surface to the camera lens is the same as the distance from the actual material's top surface to the camera lens. In the "Monitoring – IO – DO" interface, manually trigger a photo. After the vision system recognizes the image, the pixel coordinates of the feature points will be obtained.

③ In the "Settings – Plug-in Extension – Conveyor – Vision Calibration – Acquire Vision Points" interface, click "Capture Current Position." There are two ways for the robot system to obtain pixel information:

The first method is manual input. Enter the pixel values recognized by the vision system in the order of detection into Point 1, Point 2, ... Point 9.

The second method is to establish TCP communication with the vision system. The vision system sends data in the format @X1,Y1,X2,Y2...X9,Y9\r, where @ is the start character and \r is the stop character. The pixel information will be automatically parsed and populated in the interface, as shown in the figure below.





- ④ Start the conveyor to move the calibration plate into the robot workspace and then stop the conveyor. In the “Settings – Plug-in Extension – Conveyor – Vision Calibration – Acquire Teach Points” interface, click “Capture Current Position.” Use jog operation to move the robot so that the calibration tip touches the first point obtained from the vision system or manual input. Enter 1 in the “Robot Teach Point” input box. With the jog coordinate system set to tool1, wobj1 in the base coordinate system (must be ensured), click “Capture Current Point.” Use jog operation to move the robot so that the calibration tip touches the second point from the vision system or manual input. Enter 2 in the “Robot Teach Point” input box. With the jog coordinate system set to tool1, wobj1 in the base coordinate system (must be ensured), click “Capture Current Point.” Repeat this procedure to sequentially capture all the feature points recognized by the vision system.
- ⑤ After capturing all points, click “Calibrate / Upload.” In the “Settings – Plug-in Extension – Vision Calibration – Basic Parameters” interface, if it is in a disabled state, click “Modify” and change the “Vision Coordinate System Number” to the number set in Step ①, then click “OK.” Switch to the “Settings – Plug-in Extension – Vision Calibration – Vision Calibration” interface to view the maximum error of the vision calibration and the resulting calibration matrix.

5.2 Supplement

To allow the vision system to complete vision calibration and send the object position in the conveyor coordinate system to the robot system, follow these steps:

① Stop the conveyor and place the calibration plate within the camera's field of view. Take a photo to obtain the pixel coordinates of the calibration plate's feature points. Suppose there are n points, with pixel values recorded as $C1(Cx1, Cy1)$, ..., $Cn(Cxn, Cyn)$. At the same time, record the encoder value as $e1$. The vision system needs the positions of these feature points in the conveyor coordinate system at this location. However, since this position is outside the robot workspace, the points cannot be obtained by robot alignment. A conversion is therefore required, as described below.

② Start the conveyor to move the calibration plate into the robot workspace, and record the encoder value as $e2$. Suppose the calibrated conveyor coordinate system uses $user2$; a corresponding work object coordinate system can be established as $wobj2(0,0,0,0,0,user2)$. In the robot operating system, select the user coordinate system $tool1$, $wobj2$. Operate the robot to touch the calibration tip to the feature points on the calibration plate in the order defined by the vision system, obtaining their positions in the conveyor coordinate system, recorded as $R1(Rx1, Ry1)$, ..., $Rn(Rxn, Ryn)$.

③ Suppose the encoder resolution obtained from calibration is k and the direction is d . Let $(e2 - e1) \times k \times d$ be L . Then, the positions of the feature points in Step ① in the conveyor coordinate system can be calculated as $R1_ (Rx1 - L, Ry1)$, ..., $Rn_ (Rxn - L, Ryn)$. The vision system can complete calibration based on the point sets C and $R_$, and the data sent represents the physical positions of the objects in the conveyor coordinate system.

④ In the "Settings – Plug-in Extension – Conveyor – Camera Parameters" interface, if it is disabled, click "Modify," set the "Camera Data Type" to "Robot Coordinates," and click "OK."

6. Sensor Calibration

When the detection method in “Settings – Plug-in Extension – Conveyor – Basic Parameters” is set to “Sensor,” sensor calibration is required. Follow these steps:

① In the “Settings – Plug-in Extension – Conveyor – Sensor Parameters” interface, if it is disabled, click “Modify.” Set the “Sensor DI Port” to the DI number corresponding to the actual sensor hardware. Set the “Signal Type” to match the actual sensor detection polarity, which can be either “Rising Edge” or “Falling Edge.” Click “OK,” as shown in the figure below.



② Open the “Monitoring – I/O” interface. Pass the material past the sensor and check the status of the corresponding DI number. If the sensor correctly detects the material, it is functioning normally, and you can proceed to the next steps.

③ In the “Settings-Plug-in Extension-Conveyor-Sensor Calibration” interface, place the material on the conveyor (so that it can be detected by the sensor during conveyor movement). Start the conveyor and let the material pass the sensor, then stop the conveyor near the middle position between the upper and lower workspace limits. Use jog operation to move the robot so that the calibration tip touches the desired pick position on the object, and click “Read Teach Position.” Then click “Calculate Detection Position,” which will compute the position of the desired pick point in the conveyor coordinate system at the moment the sensor is triggered.