Omron TM Collaborative Robot: Conveyor Tracking

User's Manual

Original Instruction

I853-E-03

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Revision	Date	Revised Content
01	April, 2020	Original release
02	August, 2020	Added 1.80 features
03	June, 2023	Added 2.0 features

1. Introduction

TM Conveyor Tracking can obtain the position and motion of the object on a conveyor using vision and/or a sensor. The conveyor tracking software runs on TMflow and comes with the Sensor Mode and ETH mode. The Sensor Mode is the default function mode and does not require a license dongle to activate it.

To activate the Sensor Mode on TM Conveyor Tracking, users shall open a TM Conveyor Tracking project and use the features of the mode. To activate the ETH mode, however, users shall insert the TM Dongle they have purchased into any USB port on the control box. Be careful that during editing, trial runs or operation, the signal cable must remain connected to the control box. Otherwise, the project cannot be edited or the robot may stop. Under the ETH mode, the license dongle must remain inserted in the control box.

1.1 How Can I Get Help?

You can access information sources on the corporate website:
http://www.ia.omron.com/

1.2 Scope of Use

1. A single robot can support two conveyors.
2. Conveyor speed < 300 ㎜/s, average precision±1 ㎜ (when the workpiece angle variation within±15˚).

1.3 Limitations of Use

1. Functional mode combination per robot: Sensor Mode + Sensor Mode or ETH Mode + Sensor Mode for maximum two conveyors (ETH +ETH is not supported, and ETH mode requires use of license dongle)
2. Does not support two robots using one single Encoder + EtherCAT IO
3. Only supports linear conveyor (Does not support circular conveyor).
4. Does not support multiple types of objects.

NOTE:
The precision specifications in this manual only serves as reference. Upon the actual completion of automation setting, the precision specifications and calibration accuracy are influenced by environmental factors, workpiece variation, visual patterns, editing, and conveyor stability. Users still need to take actual tests.

This manual applies to TMflow Version 2.14 or later. There may be differences between the functions and interfaces of different software versions. Confirm the software version before using and reading this manual. To confirm the software version, click  at the top right of the screen for the information.

1.4 Warning and Caution Symbols

The Table below shows the definitions of the warning and caution levels used in our manuals. Pay close attention to them when reading each paragraph, and observe them to avoid personal injuries or equipment damage.

DANGER:
Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in death or severe property damage.

WARNING:
Identifies a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, and might result in serious injury, death, or significant property damage.

CAUTION:
Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.

1.5 Safety Precautions

DANGER:
This product can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed:

- All personnel who install, operate, teach, program, or maintain the system must read the *Hardware installation Manual*, *Software Manual*, and *Safety Manual* according to the software and hardware version of this product, and complete a training course for their responsibilities in regard to the robot.

Read Manual Label; Impact Warning

- All personnel who design the robot system must read the *Hardware installation Manual*, *Software Manual*, and *Safety Manual* according to the software and hardware version of this product, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The TM AI Cobot must be used for its intended use.
- Results of the risk assessment may require the use of additional risk reduction measures.
- Power to the robot and its power supply must be locked out and tagged out or have means to control hazardous energy or implement energy isolation before any maintenance is performed.

-  Dispose of the product in accordance with the relevant rules and regulations of the country or area where the product is used.

1.6 Validation and Liability

The information contained herein neither includes how to design, install, and operate a complete robotic arm system, nor involves the peripherals which may affect the safety of the complete system. The integrators of the robot should understand the safety laws and regulations in their countries and prevent hazards from occurring in the complete system.

This includes but is not limited to:

- Risk assessment of the whole system
- Adding other machines and additional risk reduction measures based on the results of the risk assessment
- Using appropriate software safety features
- Ensuring the user will not modify any safety measures
- Ensuring all systems are correctly designed and installed
- Clearly labeling user instructions
- Clearly marked symbols for installation of the robot arm and the integrator contact details
- Making accessible relevant documents, including the risk assessment and this Manual

CAUTION:
This product is a partly complete machine. The design and installation of the complete system must comply with the safety standards and regulations in the country of use. The user and integrators of the robot should understand the safety laws and regulations in their countries and prevent major hazards from occurring in the complete system.

1.7 Statement of Responsibilities for Cyersecurity Threats

To maintain the security and reliability of the system, a robust cybersecurity defense program should be implemented, which may include some or all of the following:

Anti-virus protection

- Install the latest commercial-quality anti-virus software on the computer connected to the control system and keep the software and virus definitions up-to-date.
- Scan USB drives or other external storage devices before connecting them to control systems and equipment.

Security measures to prevent unauthorized network access

- Install physical controls so that only authorized personnel can access control systems and equipment.
- Reduce connections to control systems and equipment via networks to prevent access from untrusted devices.

- Install firewalls to block unused communications ports and limit communication between systems. Limit access between control systems and systems from the IT network.
- Control remote access and adopt multifactor authentication to devices with remote access to control systems and equipment.
- Set strong password policies and monitor for compliance frequently.

Data input and output protection

- Backup data and keep the data up-to-date periodically to prepare for data loss.
- Validate backups and retention policies to cope with unintentional modification of input/output data to control systems and equipment.
- Validate the scope of data protection regularly to accommodate changes.
- Check validity of backups by scheduling test restores to ensure successful recovery from incidents.
- Safety design, such as emergency shutdown and fail-soft operations in case of data tampering and incidents.

Additional recommendations

- When using an external network environment to connect to an unauthorized terminal such as a SCADA, HMI or to an unauthorized server may result in network security issues such as spoofing and tampering.
- You must take sufficient measures such as restricting access to the terminal, using a terminal equipped with a secure function, and locking the installation area by yourself.
- When constructing network infrastructure, communication failure may occur due to cable disconnection or the influence of unauthorized network equipment.
- Take adequate measures, such as restricting physical access to network devices, by means such as locking the installation area.
- When using devices equipped with an SD Memory Card, there is a security risk that a third party may acquire, alter, or replace the files and data in the removable media by removing or unmounting the media.

1.8 Limitation of Liability

No safety-related information shall be considered a guarantee by the Corporation that a TM AI Cobot will not cause personnel injury or property damage.

1.9 Functional Note Symbols

The following table defines the functional note symbols used in this manual. Read the paragraphs carefully.

IMPORTANT:
This symbol indicates the relevant functional details to assist programming and use.

NOTE:
This symbol indicates the relevant functional use tips to assist programming efficiency.

2. Hardware Requirements

2.1 TM Dongle

Use the purchased TM Dongle to activate ETH Conveyor Tracking function.

2.2 Applicable EtherCAT Coupler and Encoder Modules

Refer to tables below regarding compatible EtherCAT couplers and encoder modules.

EtherCAT Coupler Model	VIPA: 053 -1EC00	Beckoff: EK1100	OMRON: NX-ECC201	OMRON: NX-ECC202	OMRON: NX-ECC203
Rated voltage	DC24 V	DC24 V	DC24 V	DC24 V	DC24 V
Rated current	950mA	570mA	417mA	417mA	417mA
Support Encoder Module Model	VIPA: 050-1BA00	Beckoff: EL5151/EL5152	OMRON: NX-EC0112/NX-EC0122/NX-EC0132/NX-EC0142/ NX-EC0212/NX-EC0222		

Table 1: Applicable EtherCAT coupler models

Encoder Module Model	VIPA: 050-1BA00	Beckoff: EL5151/ EL5152	OMRON: NX-EC0112	OMRON: NX-EC0122	OMRON: NX-EC0132	OMRON: NX-EC0142	OMRON: NX-EC0212	OMRON: NX-EC0222
Rated voltage	DC24 V	DC24 V	DC24 V	DC24 V	DC24 V	DC24 V	DC24 V	DC24 V
Rated current	75mA	130mA	35 mA	39 mA	39 mA	44 mA	35 mA	39 mA
Number of encoder	1	1or2	1	1	1	1	2	2
ON voltage	15-28.8V	15-30V	19.6-28.8V	19.6-28.8V	19.6-28.8V	19.6-28.8V	19.6-28.8V	19.6-28.8V
OFF voltage	0-5V	0-5V	0-4V	0-4V	0-4V	0-4V	0-4V	0-4V

Table 2: Applicable Encoder Modules

NOTE:

- Equipment needs to be connected to external power supply for proper use. For detailed product information, visit the product's official website.
- Suggested Encoder Model: E6C3-CWZ5GH

IMPORTANT:

Techman Robot Inc. is not liable for any incompatibility issue due to use of equipment not listed above.

2.3 Code Wheel

Reference specifications: wheel resolution 300 ㎜ (or 95.49 ㎜ in diameter)。

*If a different sized wheel is used, go to **4.1.1 Encoder Setting** to adjust the parameters for perimeters.

Make sure that the code wheel is flat against the conveyor to ensure its accuracy.

Figure 1: Code wheel

2.4 Camera

For detailed information about the cameras, please visit the official website of the cameras.

Specifications	Camera		
Model	Basler acA2440-20gc	Basler acA2500-20gc	Basler acA2500-14gc
Shutter	Global		Rolling
Sensor	Color 2/3 inch	Color 1 inch	Color 1/2.5 inch
Connection interface	GigE interface		
Remark	When conveyor speed < 300 ㎜/s, the average tolerance is ±1 ㎜.	When conveyor speed < 300 ㎜/s, the average tolerance is ±1 ㎜.	Rolling shutter camera is recommended to be used at low speed (conveyor speed < 100 ㎜/s) and when precision requirement is lower.

Table 3: Camera

IMPORTANT:
Techman Robot Inc. is not liable for any incompatibility issue due to use of equipment not listed above.

2.4.1 Lens

It is strongly recommended to use an industrial-grade C/CS Mount lens. The lens focal distance should be set based on the real-world applications.

Lens selection example (object is 500 mm away from the camera)

Reference for calculation:

- When using a 12 mm lens, the field is 232 x 174 mm^2; pixel resolution is 232/2590 ~ 0.09 mm /pixel.
- When using an 8 mm lens, the field is 351 x 263 mm^2; pixel resolution is 351/2590 ~ 0.14 mm /pixel.

2.5 Reference Guide for Light Source Setup

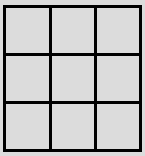
To obtain decent image quality and rapid imaging time, it is strongly recommended that the light source intensity of the image range can reach to 2500 Lux, with uniformity higher than 90% to avoid light reflection.

At light levels below 2500 LUX, it may be necessary to increase the camera exposure time and decrease the conveyor belt speed.

For example (when the camera is 500 mm from the focus object):

When the light intensity is 2500 Lux, exposure time setting should be set as 0.5 ms, and the conveyor speed shall be set to 300 mm/sec;

Calculation of Uniformity：
Divide the camera field into a 3 x 3 grid as in the following figure. Measure the brightness in the center of each cell and obtain the maximum and minimum value,



Substitution：

$$\text{Uniformity} = \left|1 - \frac{(Max - Min)}{(Max + Min)}\right| \times 100\%$$

2.6 Sensor

Choose the most appropriate sensor based on the object material that needs to be detected.

When using Sensor Mode, it is strongly recommended using the official TM AI Cobot Calibration Set for positioning. When setting CVPoint is required, switch back to the specific tool for your application.

NOTE:
To purchase TM Calibration Set, contact your local distributor or dealership.

2.7 Light Box Design Reference

For relevant details about reference design of light box, contact your local distributor or dealership.

2.8 Hardware Connection Diagram

The diagram below shows the recommended hardware connection.

For details about the supply voltage of the power socket, refer to the robot in use.

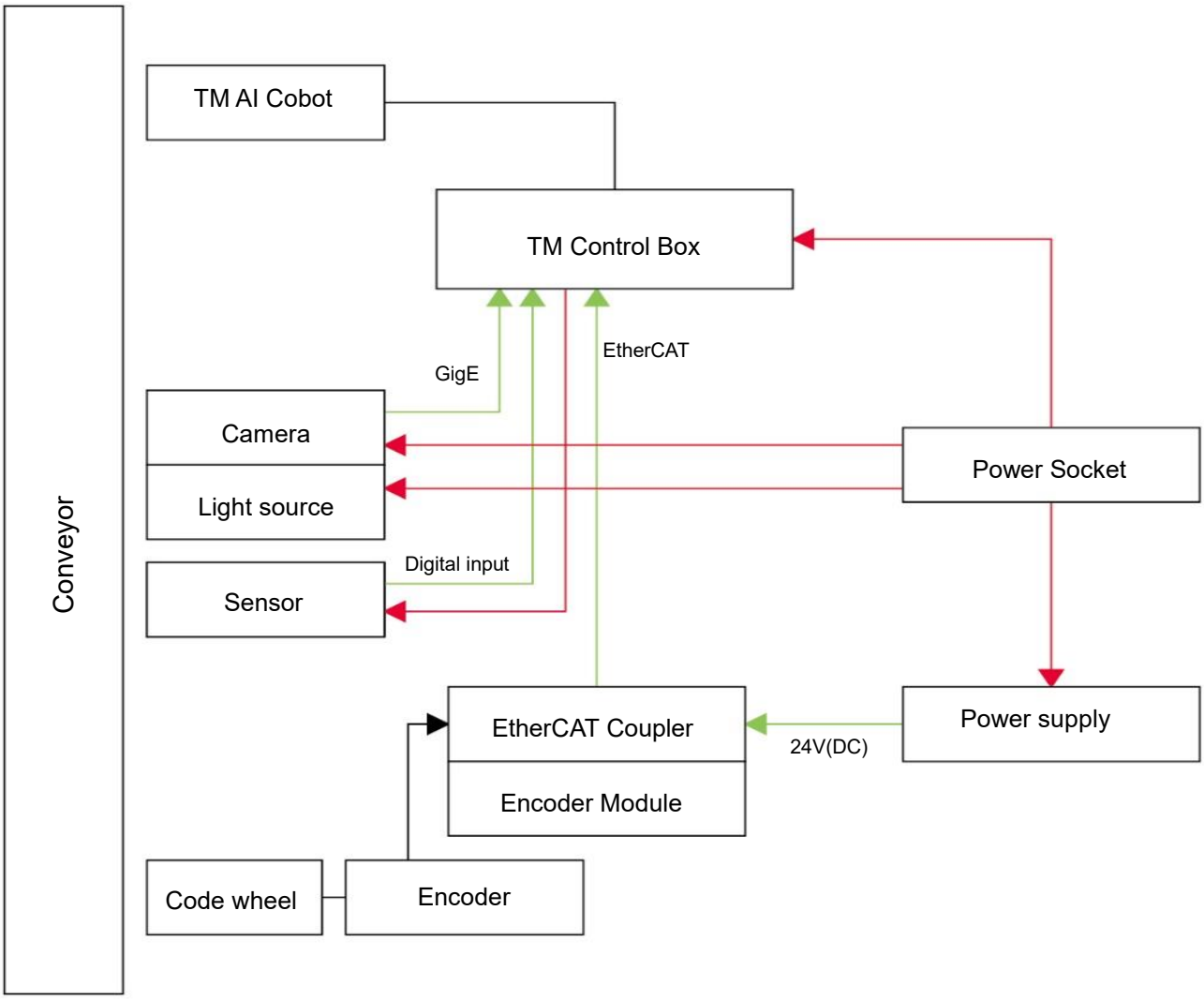


Figure 2: Hardware connection diagram

3. Operating Guide

Under the Sensor Mode, click **New** > **New Flow** on the top-left corner of TMflow, click **Conveyor Tracking** and select **Conveyor_0** (using only one conveyor) or **Conveyor_1** (using two conveyors), then choose **Sensor Mode** to create a conveyor tracking project. To use the ETH mode, insert the TM dongle into the control box before activating TMflow, and after TMflow is activated, click **New** > **New Flow** > **Conveyor Tracking** > **Conveyor_0** or **Conveyor_1** > **ETH Mode** to create a conveyor tracking project.

Select "**Conveyor_0**" or "**Conveyor_1**"

- Conveyor_0: application requires only one conveyor
- Conveyor_1: application requires two conveyors

IMPORTANT:
To start any new Conveyor Tracking project with one connected conveyor, choose **Conveyor_0** or **Conveyor_1**.

TM Conveyor Tracking supports two operating modes:

- **Sensor Mode**: detect the objects passing through the sensor beam (default mode)
- **ETH Mode**: obtain object position through camera imaging (requires a license dongle)

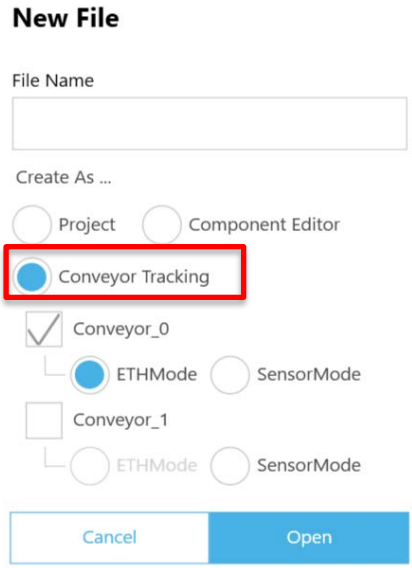


Figure 3: Create new project

3.1 Sensor Mode

Sensor Mode consists of a robot and external sensors. The sensor will detect objects passing through the sensor beam. Application diagram of Sensor Mode is presented in Figure 4.

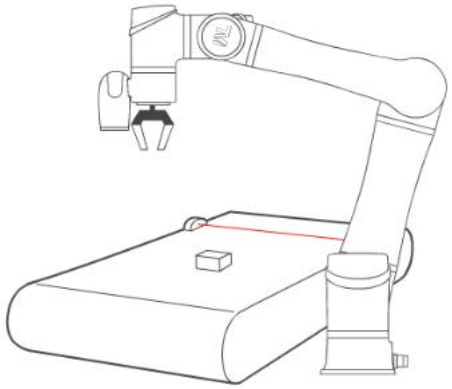


Figure 4: Sensor Mode diagram

3.2 ETH Mode

ETH Mode is composed of a robot, an external camera, and light sourcing devices. Application diagram of ETH Mode is shown in Figure 5.

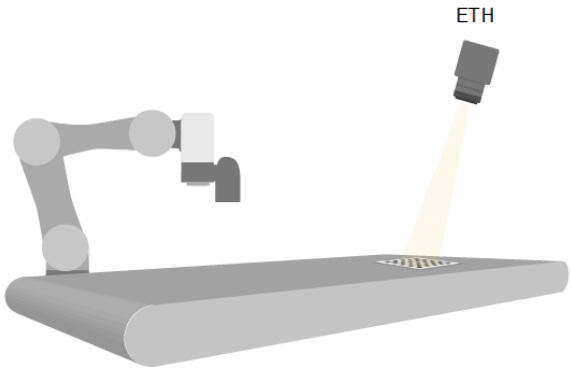


Figure 5: ETH Mode diagram

***** Currently, TM Conveyor Tracking only supports Sensor Mode by default. For purchase of ETH Mode license, consult with your local representatives.

4. Software Functions

4.1 Conveyor Tracking Setting

After opening the Conveyor Tracking project, click the pencil icon of the Start Node to set the encoder parameters, working boundary, camera and advanced conveyor parameters such as vectors. Further description will be discussed in the following.

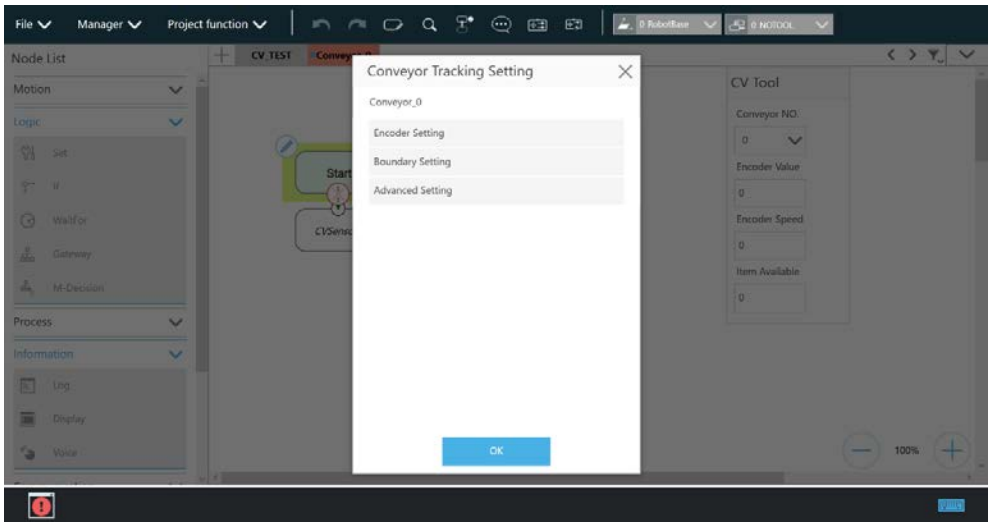


Figure 6: Conveyor Tracking Setting

4.1.1 Encoder Setting

Encoder setting allows users to set resolution and encoder wheel perimeters.

Encoder Resolution: Encoder resolution by Pulse/Rev

Wheel Resolution: encoder wheel circumference (㎜).

Reverse (Reverse rotation): when the conveyor is operating, the speed indicator should be in positive values. If shown in negative values, select “Reverse”.

The officially designated encoder model is the Omron E6C3- CWZ5GH 2000P/R 2M. However, settings shall be based on the actual encoder hardware used by users.

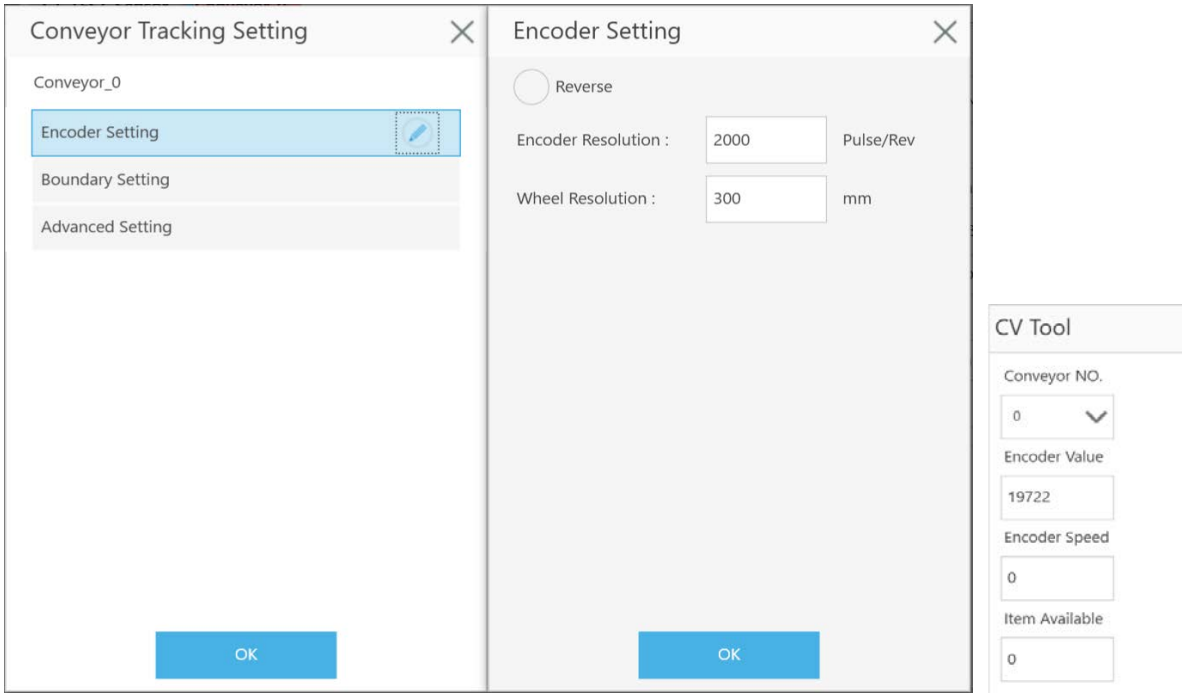


Figure 7: Encoder setting

4.1.2 Boundary Setting

Set the working area boundary for the robot.

B Start: Work start point

B End: Work end point

Range: Robot working range

Recommended maximum ranges:

- 650 mm (TM5-700 model)
- 850 mm (TM5-900 model)
- 1250 mm (TM12)
- 1050 mm (TM14)
- 850 mm (TM16)
- 1250 mm (TM20)

  *Regarding the actual movement range, please refer to the 6DOF Workspace for the respective user manual of each robot model.

New object range: the range robot selects new object (this range is executed in CVNewObj node)

Working Area: Actual work range, based on the intersecting boundaries of **B Start** and **B End**. If there is no intersecting point (in which case, for example, **B Start** is set to be small while **B End** is set to be very large, the system will use **Range** to determine the working area.

Robot Base: Robot placement position.

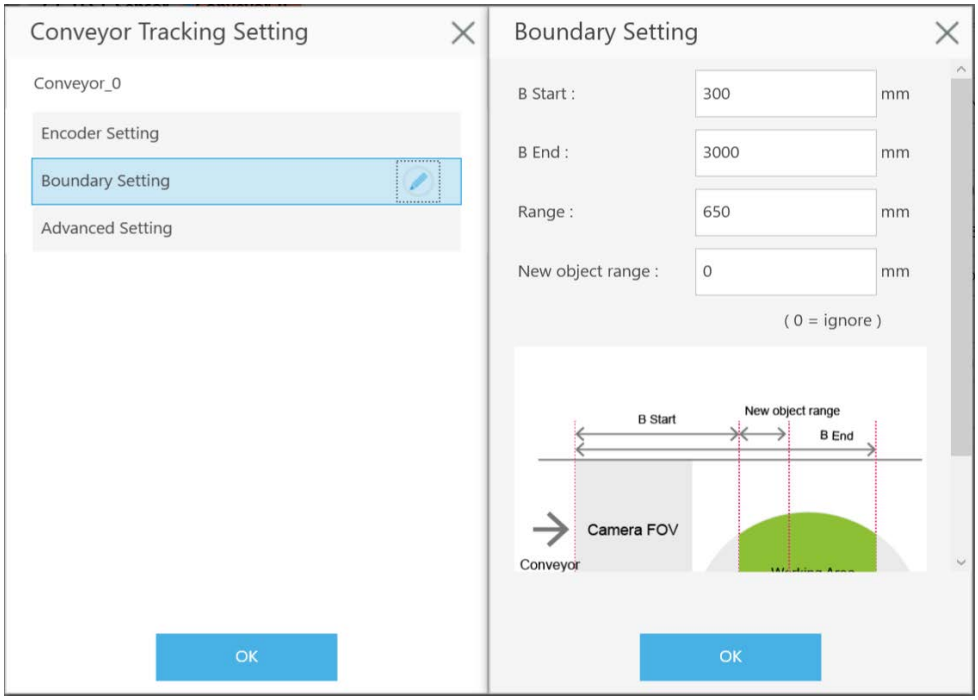
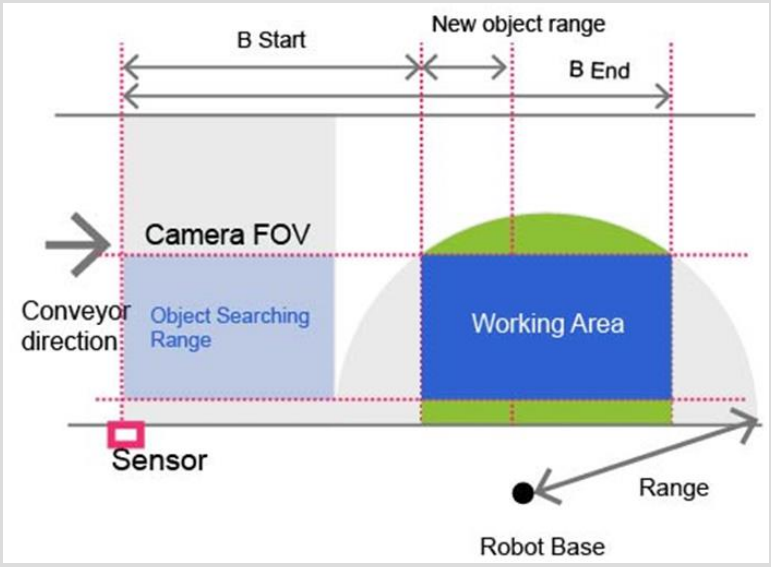


Figure 8: Boundary setting

NOTE:

In ETH mode, user can use "Set Search Range" on ETH camera vision job "Find" to limit the width of working area on the conveyor belt, which constitutes an rectangular robot working area.



4.1.3 Advanced Setting

Advanced Setting is used for setting conveyor object compensation. Description is as follows:

Conveyor Vector Compensate

(Calibration Point 2)

X offset (㎜): when adjusting calibration, compensate the calibration plate x direction offset

Y offset (㎜): when adjusting calibration, compensate the calibration plate y direction offset

Z offset (㎜): when adjusting calibration, compensate the calibration plate Z direction offset (Based on Robot Base coordinates, correct the X/Y/Z offset of Calibration Point 2 coordinates)

Maximum object moving distance in a frame (ETH Mode only): this function prevents a single object from being detected as multiple objects.

- If a single object is detected as multiple objects, increase the value.
- If multiple objects are detected as a single object, decrease the value.

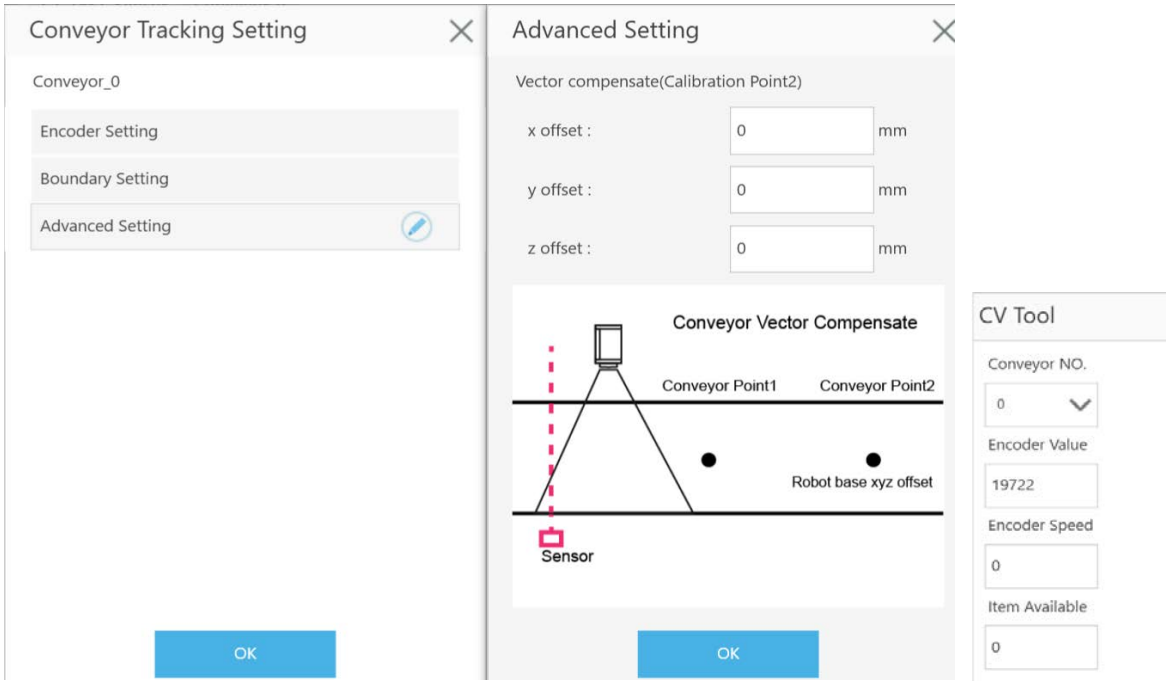


Figure 9: Advanced Setting

Note

NOTE:

- When executing Conveyor Tracking project, click “View Page” from the drop-down menu on the top-left corner of TMflow and click “Conveyor Data” to adjust Advanced Setting.
- Advanced Setting does not support Warp Node project switching. If your project would use Warp Node, remember to set Advanced Setting first and then use Warp.

4.2 CVSensor1

Click the pencil icon of CVSensor1 to set the sensor calibration.

Conveyor NO.: current conveyor in use. It is a fixed number.

I/O Number: The number of Digital Input channel of the control box connected to the sensor. The number must be set in order to trigger the sensor.

Enable Time: sets the minimum trigger time of the sensor. If the sensor trigger time is lower than Enable Time, this signal will not be considered as an object moving pass the sensor.

Rising Edge Detect: the default is checked, indicating the signal is active High when an object is detected by the sensor.

- When no object passes through the sensor beam, the signal is Low.
- When an object passes through the sensor beam, the signal is High.

Then, click “**Start Calibration**”.

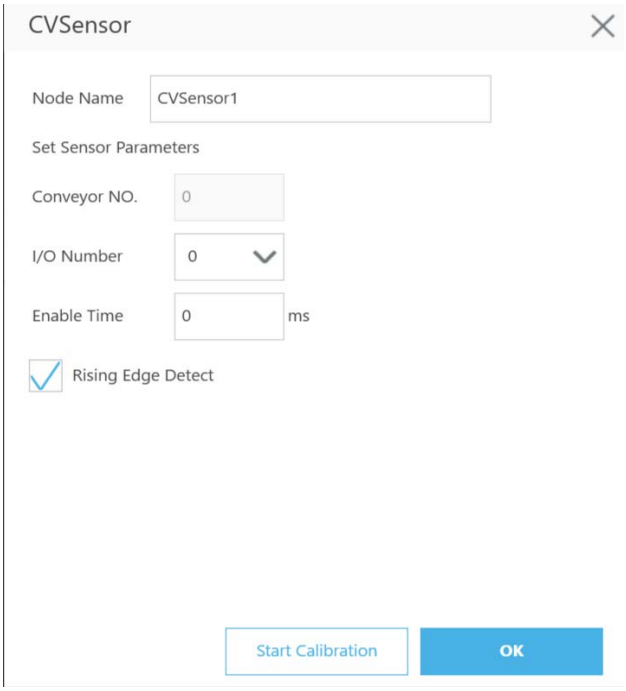


Figure 10: CVSensor

Follow the instruction on the screen to perform calibration. Users have to calibrate two Calibration Points.

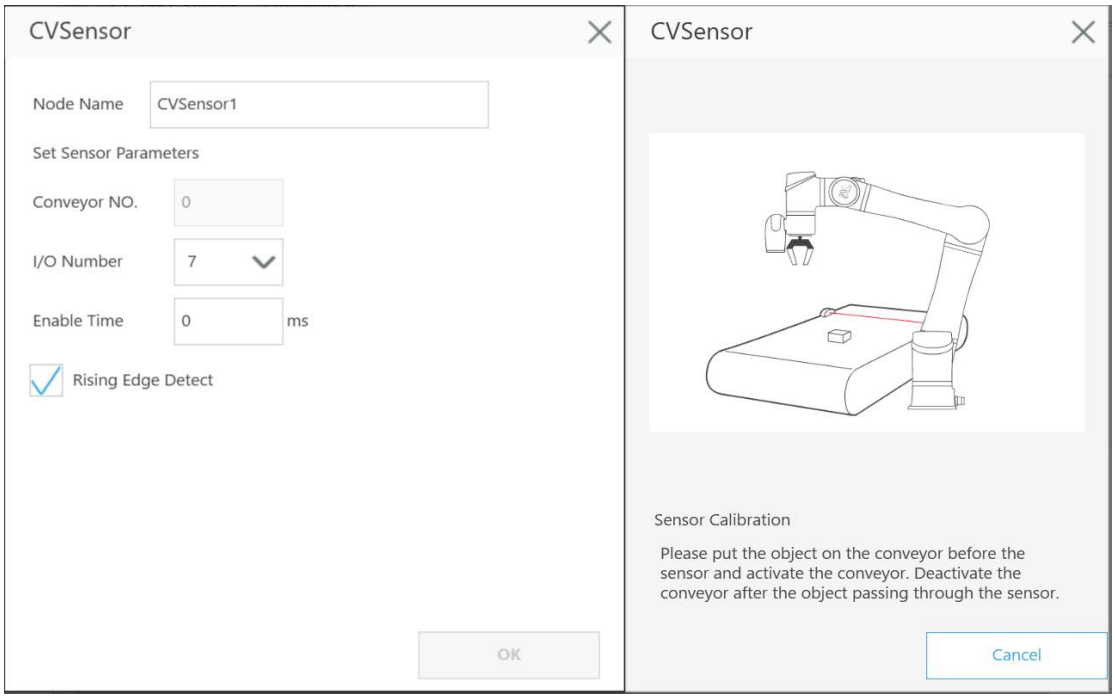


Figure 11: Sensor calibration

NOTE:
Users are not required to move the robot arm when clicking Next and Finish.

4.3 Main Thread Nodes

4.3.1 CVNewObj Node

Return to **Conveyor main thread** to select **CVNewObj** node.

This node indicates that the robot is waiting for valid objects that have been detected by the sensor and will move to the robot's New Object Range within the Working Area (refer to **4.1.2** for details about range and area).

When dragging this node, users are required to select Conveyor_0 or Conveyor_1.

Conveyor NO: Selected conveyor.

Time Out: Set the waiting time for a valid object, which is detected within New Object Range.

- When Time Out = 0, it indicates no time out is set.

When a valid object enters the robot operating range, the thread will go to the next node.

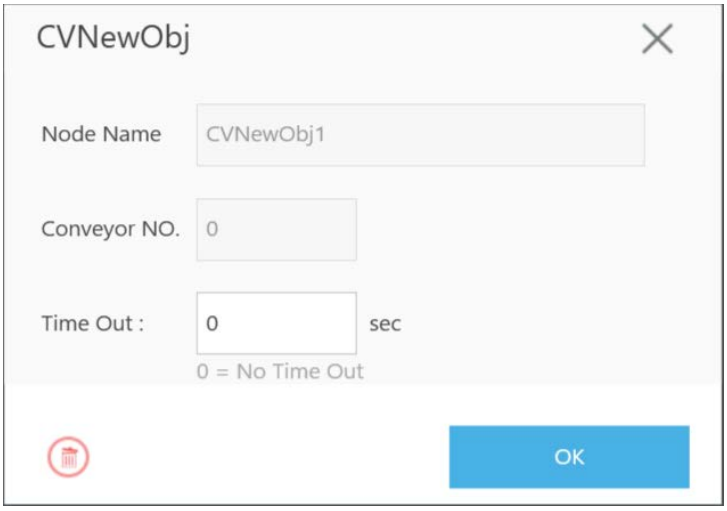


Figure 12: CVNewObj

4.3.2 CVPoint Node

CVPoint Node sets the linear motion under Conveyor main thread. This node is mainly used to track object motion through the conveyor in linear motion.

NOTE:
Under ETH Mode, the tool end will rotate along with the object. However, in Sensor Mode, the tool end will not rotate along with the object.

When dragging the CVPoint node, users are required to select Conveyor_0 or Conveyor_1, and then set Pass Path or Fail Path.

Pass Path: If the time for a valid object to reach New Object Range is less than Time Out, it is a Pass Path.

Fail Path: If the time for a valid object to reach New Object Range is greater than Time Out, it is a Fail Path. Users may drag the Fail Path to connect other nodes, such as Display, for error handling purposes.

Conveyor NO: Selected conveyor

Follow Time: Set the stopping time after the CVPoint tracks to position.

Get Point: Set the CVPoint above the object.

Teach: Set the steps for objects that pass the sensor on the conveyor.

Analog Input: Set stop criteria via analog I/O setting for control box, end module or other peripherals.

Digital Input: Set stop criteria via digital I/O setting for control box, end module or other peripherals.

Motion Settings: Set the motion speed of the CVPoint in-position process.

Digital Output: Set the output status of the control box or tool end.

Output Variables: The CVPoint outputs the current motion state via the custom variables. The output variables can go with Plug&Play software package to control the end tools.

Blending: Enable the robot to move to different points in a smooth way.

Advanced Settings: Switch the end tool. The CVPoint changes the in-position pose by the end tool setting.

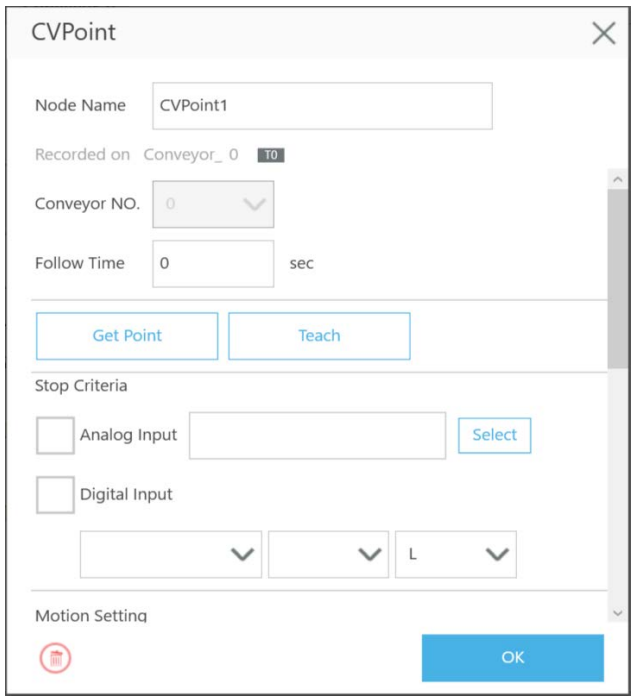


Figure 13: CVPoint

Note

NOTE:

1. If the object remains in its original position, users do not have to re-teach the robot in sensor-setting nodes CVPoint and CVCircle.
2. Methods to reset corresponding relations between the robot and the object:
   - Sensor Mode: redo 5.1 Step. 12. If the Encoder device has been replaced, resume to the thread with CVSensor1 to reset the sensor.
   - ETH Mode: redo 5.2 Step. 9 to Step. 17. If the Encoder device has been replaced, create new vision job in sub-thread.

The following provides instructions about **Teach** and **Get Point** under CVPoint Node.

When entering “Teach”, follow the instruction to place object on the conveyor and in front of the sensor. Activate the conveyor. When the object is within robot working area, deactivate the conveyor.

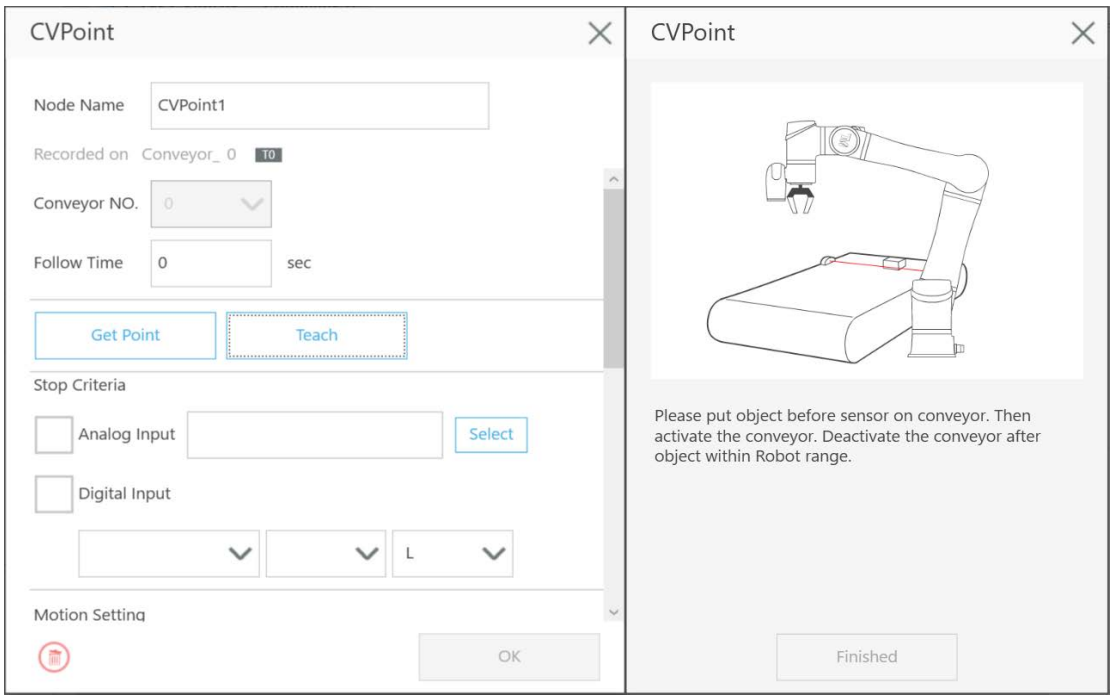


Figure 14: Teach

Get: Automatically obtain the relative position values of the identification points on the tool and the object. Click **OK** after clicking **Get**. (Note: Please reset when the values of X, Y, and Z are unreasonable.)

Set: Save result and return to the previous page. (Note: If the project comes with a value obtained CVPoint node, users can directly edit the values in the newly added CVPoint node and click **OK**.)

: Go back to the previous page without making any changes.

The other setting of the CVPoint node is the same as the parameters of the Point Node.

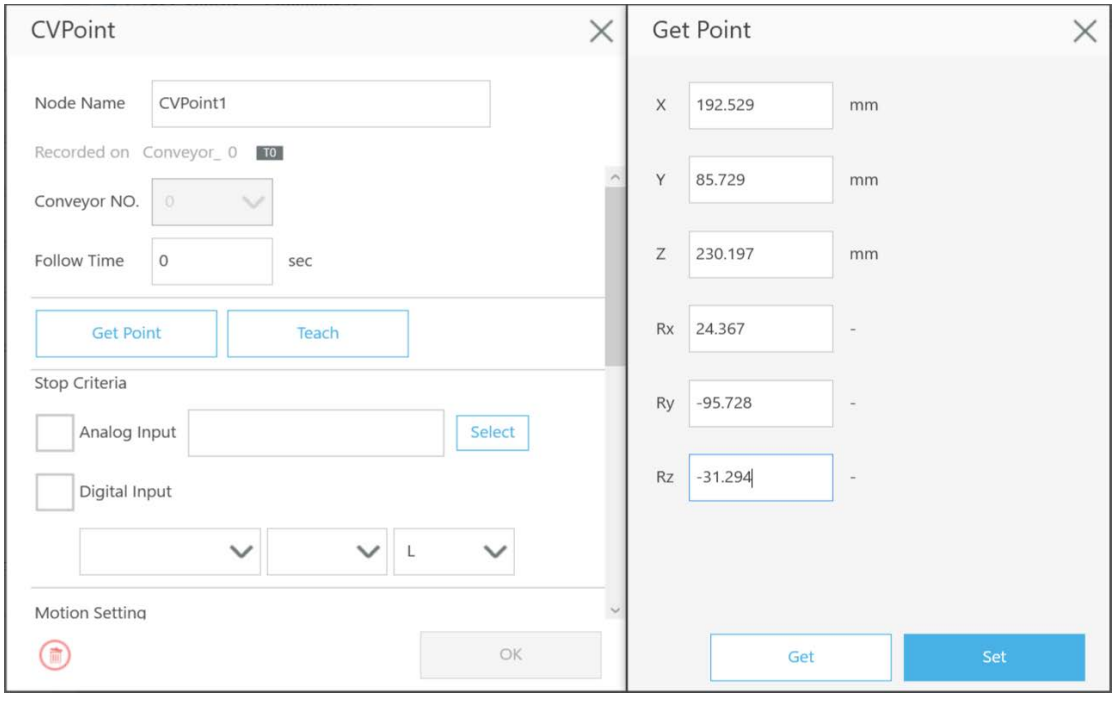


Figure 15: Get Point

Note

NOTE:

- If the values in **Get Point** are unreasonable or the object is beyond the defined range to work, users must recalibrate the object position (calibration for Sensor Mode, and saving new source images in the vision job for ETH Mode). If the project has CVPoint Node with pre-obtained values, users may just enter values to update the pre-obtained values when adding a new CVPoint Node. Then click OK to save the results. Analog/Digital IO could be set to control the component to grip/release or other implementation before the Follow Time of CVPoint.

4.3.3 CVCircle Node

CVCircle Node is a circular motion setting node under Conveyor main thread, used for specific applications, such as a gluing operation where a circular part is placed on a moving linear conveyor.

When dragging the CVCircle node, users are required to select Conveyor_0 or Conveyor_1.

Conveyor NO.: shows the selected conveyor. It is a fixed number.

Follow Time: Set the stopping time after the CVCircle tracks to position.

Degree: Set the movement path circular angle according to the established arc. Set the degrees for the movement path based on the arc established by the points.

Teach: Set the steps for objects that pass the sensor on the conveyor (Re-teach is not necessary if the object remains in the same position under CVPoint and CVCircle)

Get Point 1/2/3: Set CVCircle point. (P1 starting point, P2 midpoint, and P3 end point). Similar to CVPoint, the only difference is that three different points need to be set to form an arc.

The remaining setting of the CVCircle is the same as the CVPoint.

Analog Input: Set stop criteria via analog I/O setting for control box, end module or other peripherals.

Digital Input: Set stop criteria via digital I/O setting for control box, end module or other

peripherals.

Motion Settings: Set the motion speed of the CVCircle in-position process.

Digital Output: Set the output status of the control box or tool end.

Output Variables: The CVCircle outputs the current motion state via the custom variables. The output variables can go with Plug&Play software package to control the end tools.

Blending: Enable the robot to move to different points in a smooth way.

Advanced Settings: Switch the end tool. The CVCircle changes the in-position pose by the end tool setting.

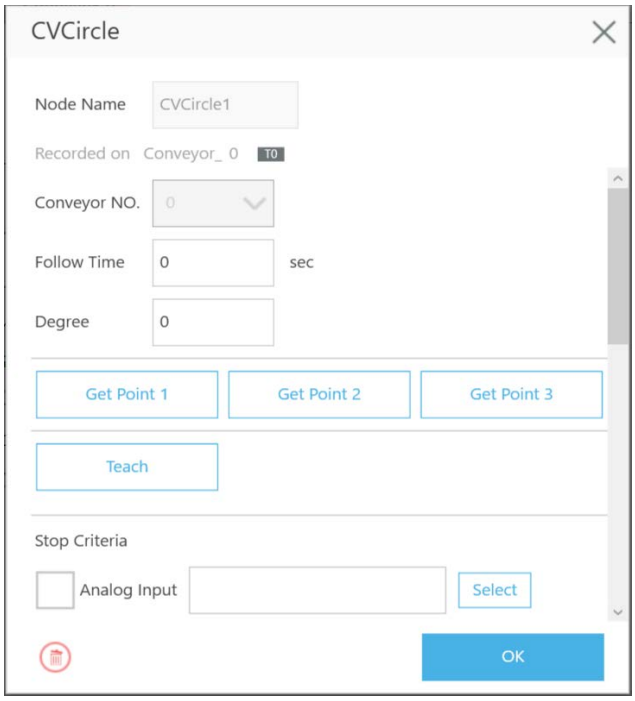


Figure 16: Get Point

5. Quick Walk-Through

5.1 Sensor Mode

1. Create new Conveyor Tracking project
   A. Start a new project by clicking **New** > **New Flow** from the Project page in TMflow
   B. Check the Conveyor Tracking box
   C. Select the conveyor
      - Choose Conveyor_0 if 1 conveyor is used
      - Choose both Conveyor_0 and Conveyor_1 if 2 conveyors are used
   D. Select **Sensor Mode**.
   E. Enter project name and click **Open**.

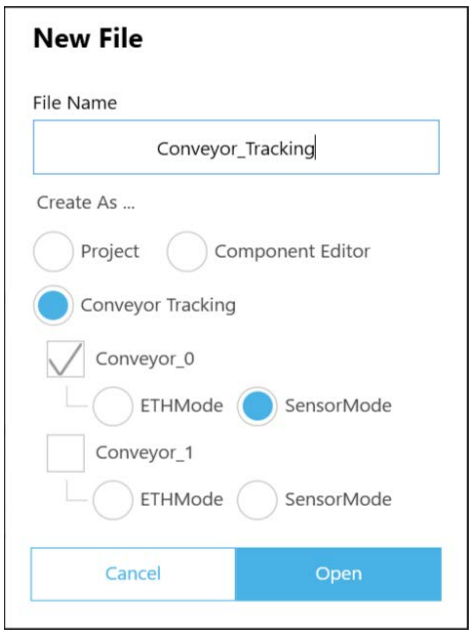


Figure 17: Create new project

2. Conveyor Tracking project appears
   A. Two threads appear
   B. One is the main thread to edit the movement procedure of the robot (the name of this thread shall appear identical to the project name you entered in **Step 1**)
   C. Another is the sub-thread, which is Conveyor_0 in **Figure 18**. This thread is configuration-only and cannot add any node.
   D. The sub-thread must be edited before the main thread can be edited.

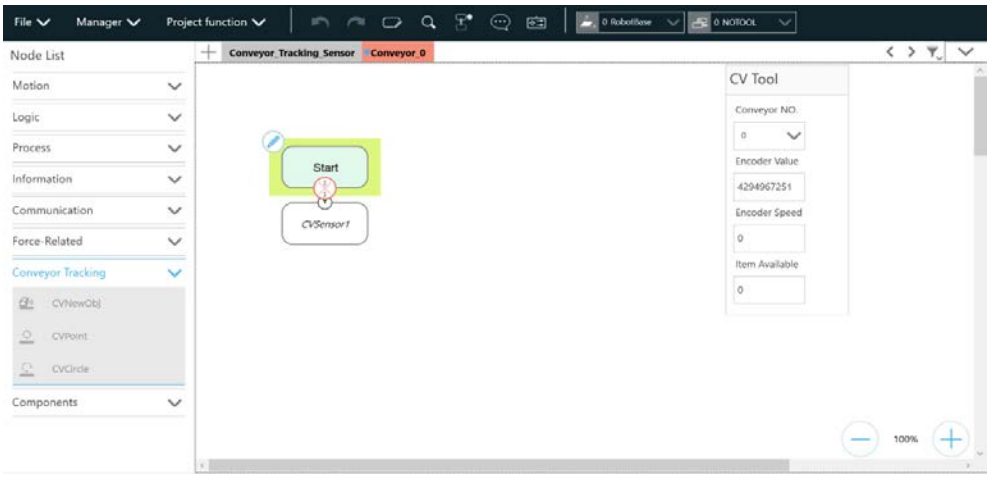


Figure 18: Start the project

3. Enter Conveyor Tracking Setting

   A. Click the pencil icon the start node in the sub-thread to proceed with Conveyor Tracking Setting.

   B. For details, refer to **4.1**.

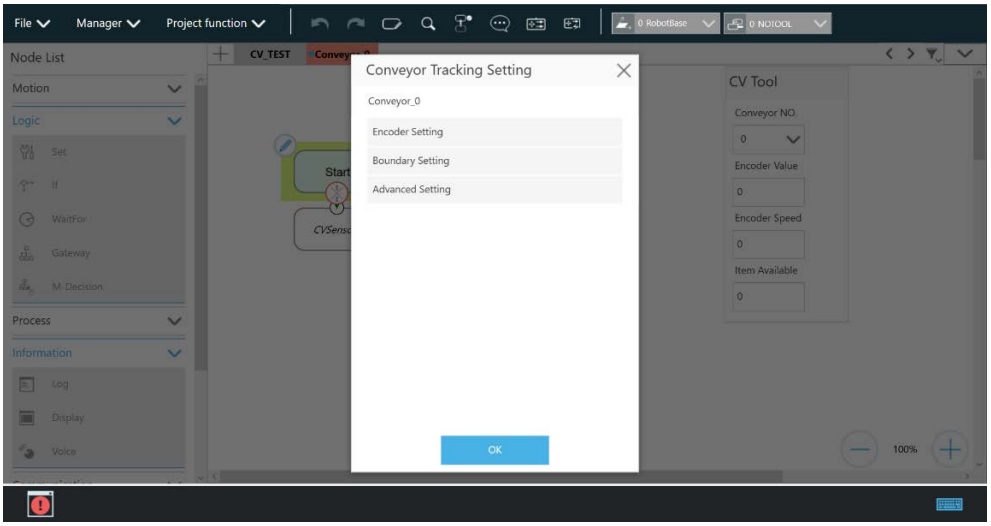
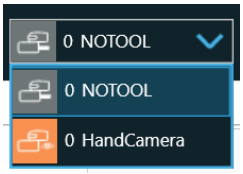


Figure 19: Conveyor Tracking Setting

4. Select Tool for your conveyor tracking project.

   Default options are “NOTOOL” and “HandCamera”.



   To ensure consistent precision, it is strongly recommended to use TM Calibration Set while teaching the two CV points.

5. Click the pencil icon of the CVSensor node.

Set IO parameters based on the sensor's IO position and the sensor trigger signal.

- **Conveyor NO.**: it's a fixed number for the selected conveyor number
- **I/O Number**: The number of DI (Digital Input) on the control box connected to sensor. The number ranges from 0 to 15.
- If the trigger signal is high, select **Rising Edge Detect**.
- For details about I/O Number and Enable Time settings, refer to **4.2**.
- Then click **Start Calibration** for the sensor.

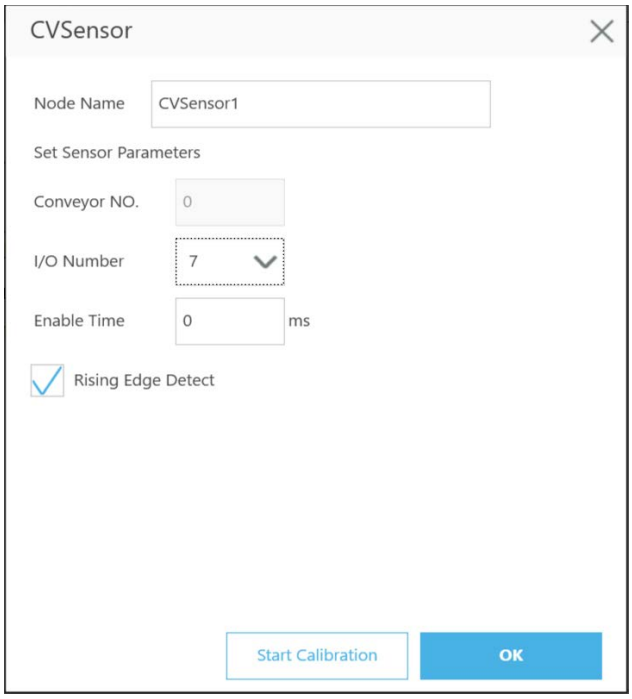


Figure 20: CVSensor

Upon entering calibration, follow the instructions shown in the image (**Figure 21**).

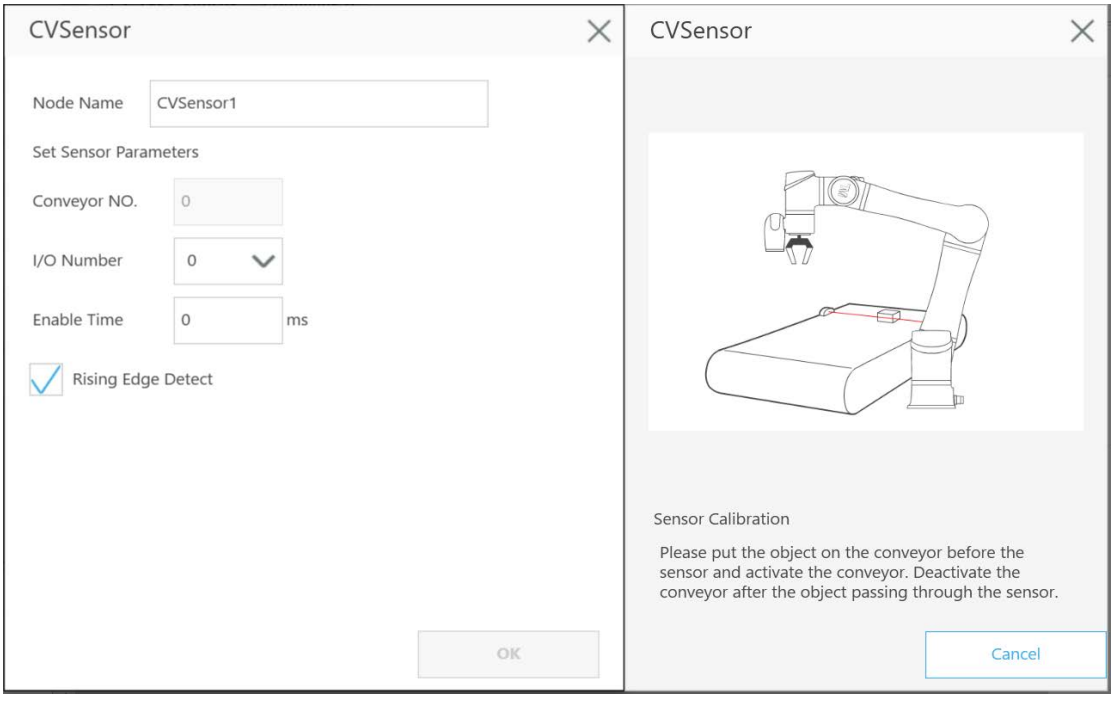


Figure 21: Sensor calibration

6. Calibration
   A. When the conveyor is stopped as instructed in the last step, click **NEXT**.
   B. Activate the conveyor again to set it in motion. Stop the conveyor when the part is in the robot's working area.
   C. Click **Finish** to set Calibration Point 2.
7. Switch back to main thread to select the tool to use during the application
8. Drag a Point Node to the project editing page and set it as the robot's initial work point.

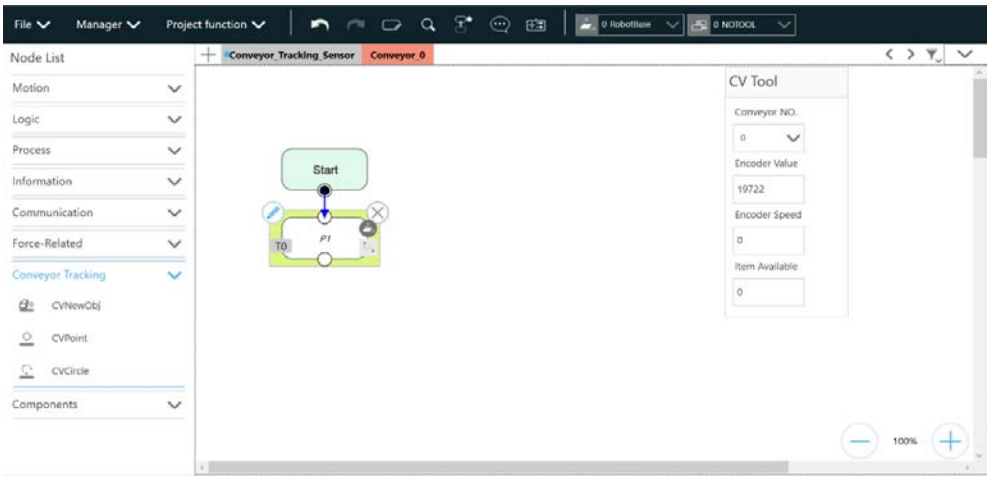


Figure 22: Point Node

9. Drag a CVNewObj Node to the project editing page and select the conveyor number.

Figure 23: Select conveyor number

10. Click the pencil icon of the CVNewObj node for the Time Out setting. For details, refer to **4.3.1**.

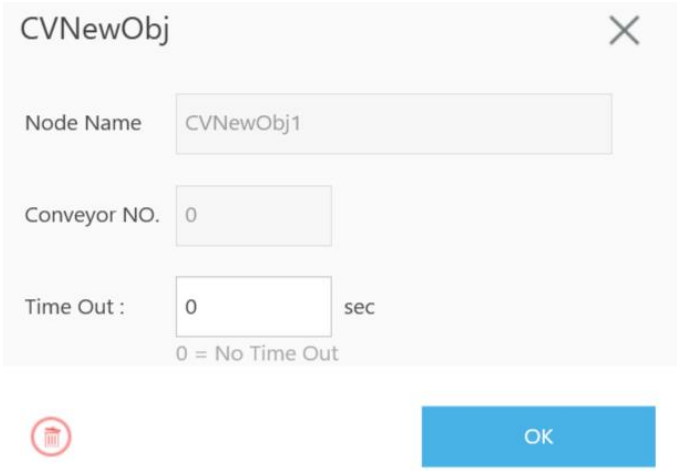


Figure 24: Set CVNewObj

11. Drag a CVPoint Node to the project editing page, select the conveyor, and set **Pass Path** or **Fail Path**. For details of the path setting, refer to **4.3.2**.

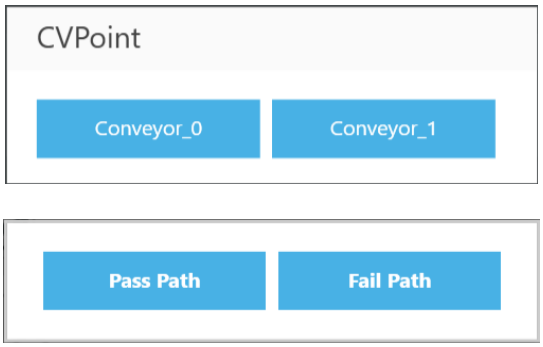


Figure 25: Select conveyor number and path

12. Click the pencil icon of CVPoint's, and click **Teach**.

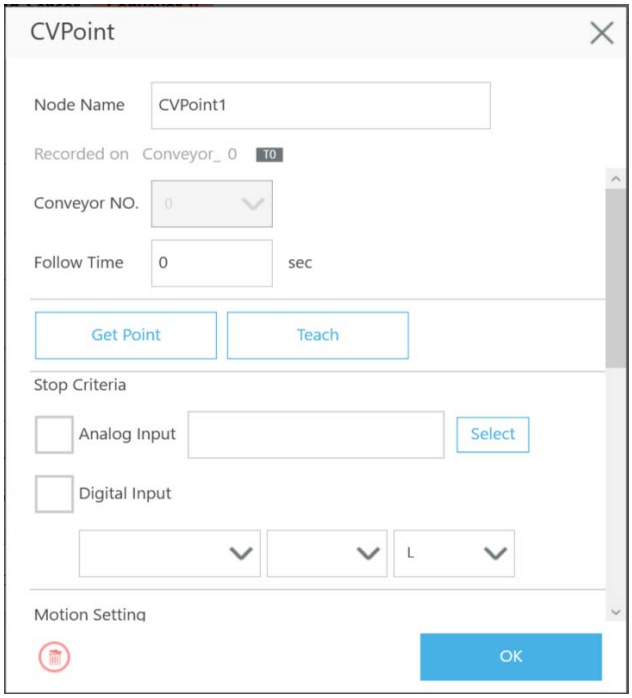


Figure 26: CVPoint

When the teaching instruction appears, use the conveyor belt to flow the object through the sensor. After the sensor has detected the object, click the **Finish** button under the teaching instruction so that the relative relationship between the robot and the object can then be established for conveying.

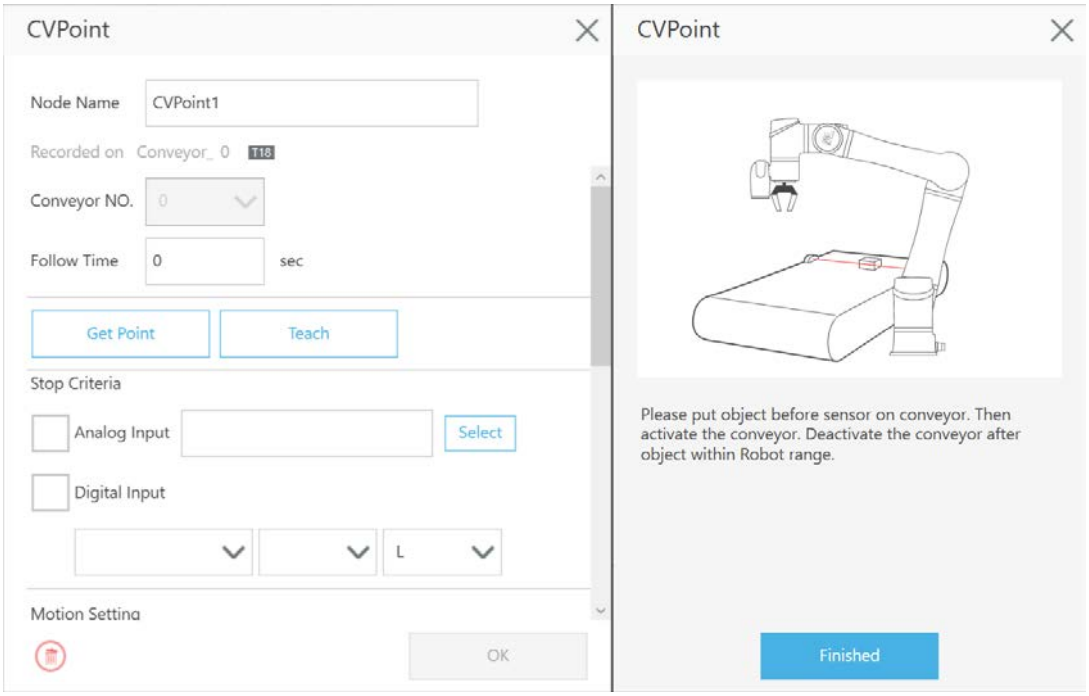


Figure 27: Teach

After passing the sensor, user the conveyor belt to move the object in the working range of the robot. Click **Finish** to go back to CVPoint, then click **Get Point** > **Get** > **Set** to complete the setting.

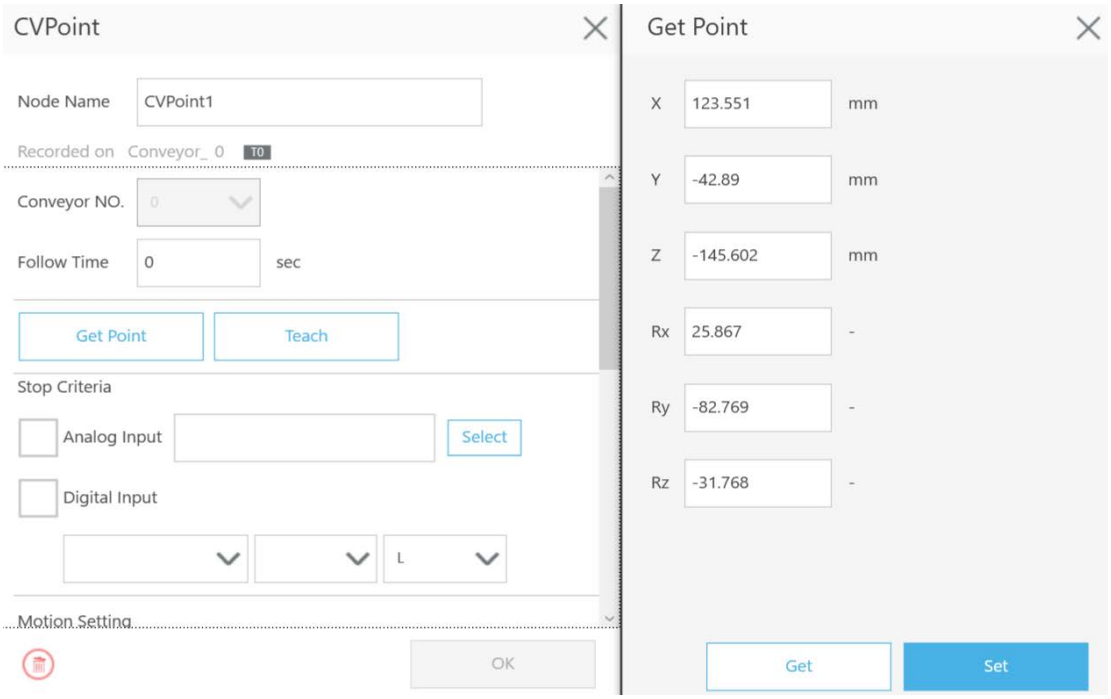


Figure 28: Get Point

13. Make the flow an infinite loop to form a simple object tracking process.

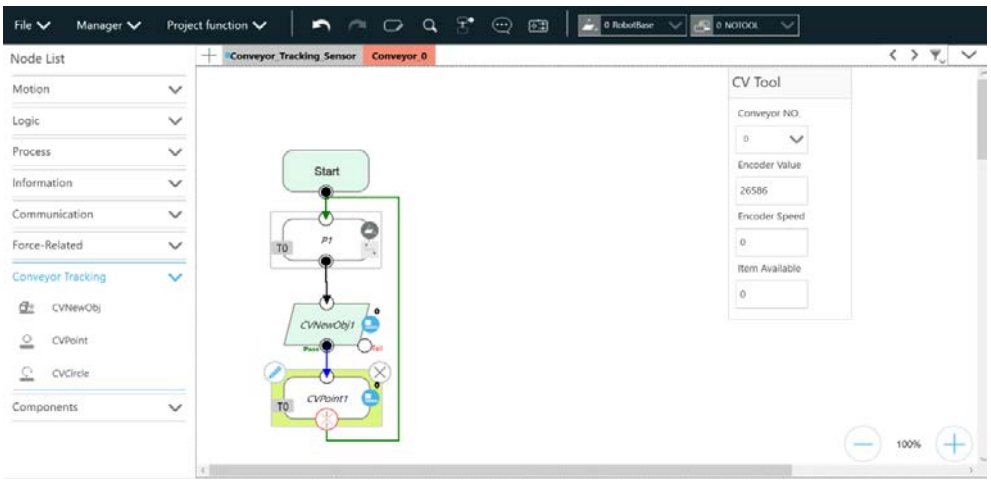


Figure 29: Form a loop

Note

NOTE:
Use either the advanced setting of gripping objects to go with the CVPoint's end tool I/O status and the point position setting or the output variables to go with Plug&Play software package to control the end tool to complete the gripping and releasing process.

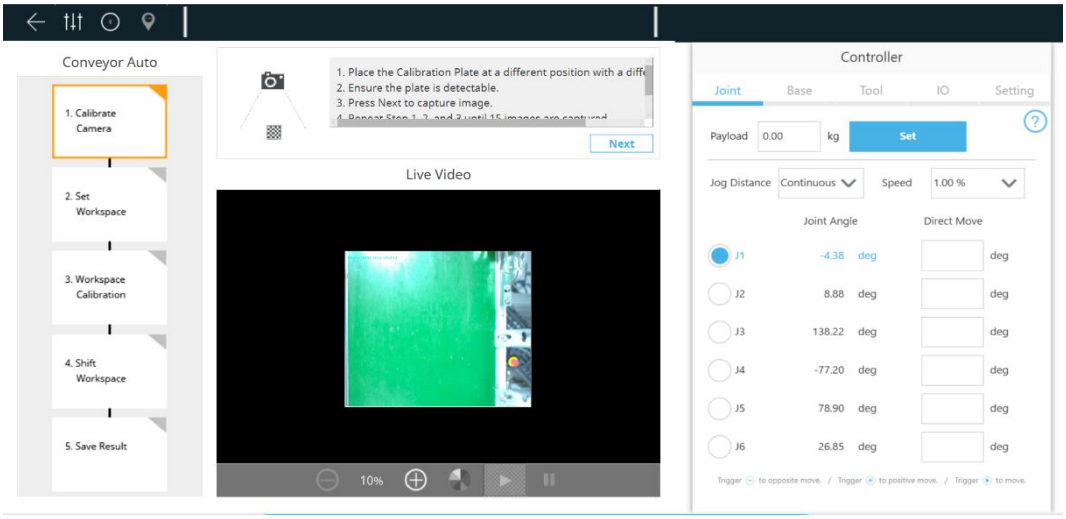
5.2 ETH Mode

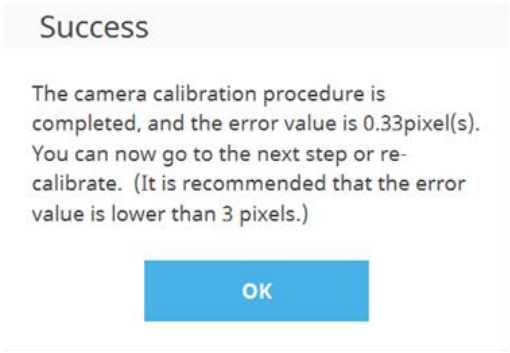
ETH requires the purchase of a TM Dongle, and the Dongle must be inserted into the control box before TMflow is activated.

1. Navigate to **Configuration** > **Vision Setting** and click **Calibration**. Choose the Conveyor Tracking camera in the Camera List at the left. (If the camera is used for the first time, it will appear as **Unknown** and with the **Un-Calibrated** state. If not, the camera appears as **Conveyor Tracking** and with the **Calibrated** state. The example below is an un-calibrated one.)

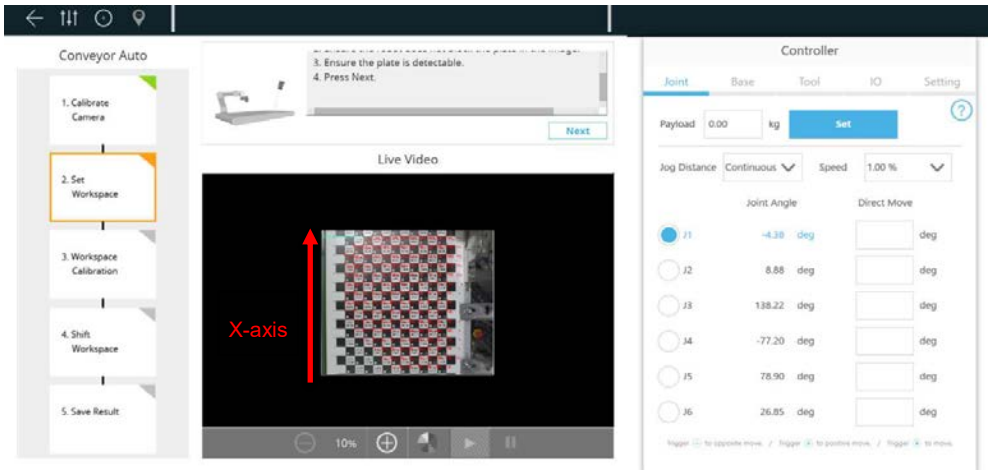
2. Click **Conveyor-tracking** in **Select Application**, then click **Automatic**.

   - **Camera calibration**: By the instructions on the screen, put the calibration plate under the Conveyor Tracking camera. In addition, users have to get 15 shots in different angles and directions and ensure the shots are not distorted (this depends on whether the calibration plate is tilted).





- **Set Workspace:** Confirm to align the calibration board's x-axis with the conveyor direction and the board's y-axis with the edge of the screen (same for automatic and manual). The main goals of the step are to
  - ➢ obtain a precise value for the position of any object relative to the edge of the camera FOV, and
  - ➢ ensure more precise coordinates of any object in the image to avoid taking repeated photos of the objects.



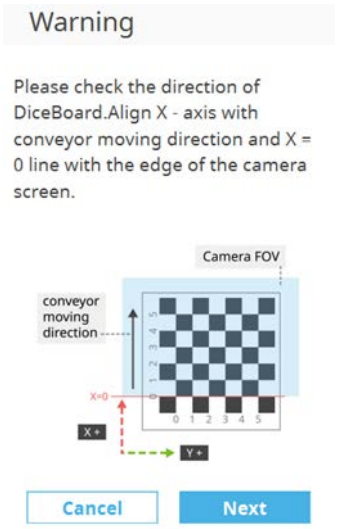


Figure 30: Set Workspace

- **Calibrate Workspace**: Follow the instructions on the screen, and move the robot above the calibration board. Then press the **PLAY** button on the robot stick to start visual navigation.

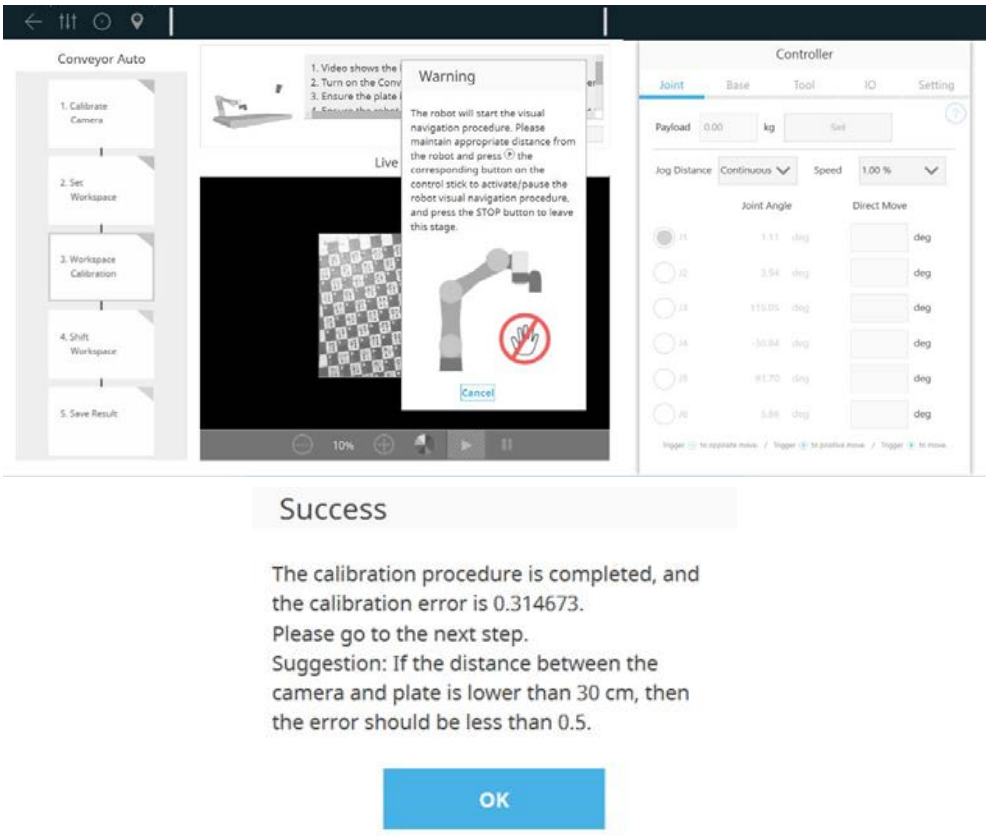


Figure 31: Calibrate Workspace

- **Shift Workspace**: In this step, users have to turn on the conveyor again and make the calibration board shift to another position. Then press the **PLAY** button on the robot stick to start visual navigation.

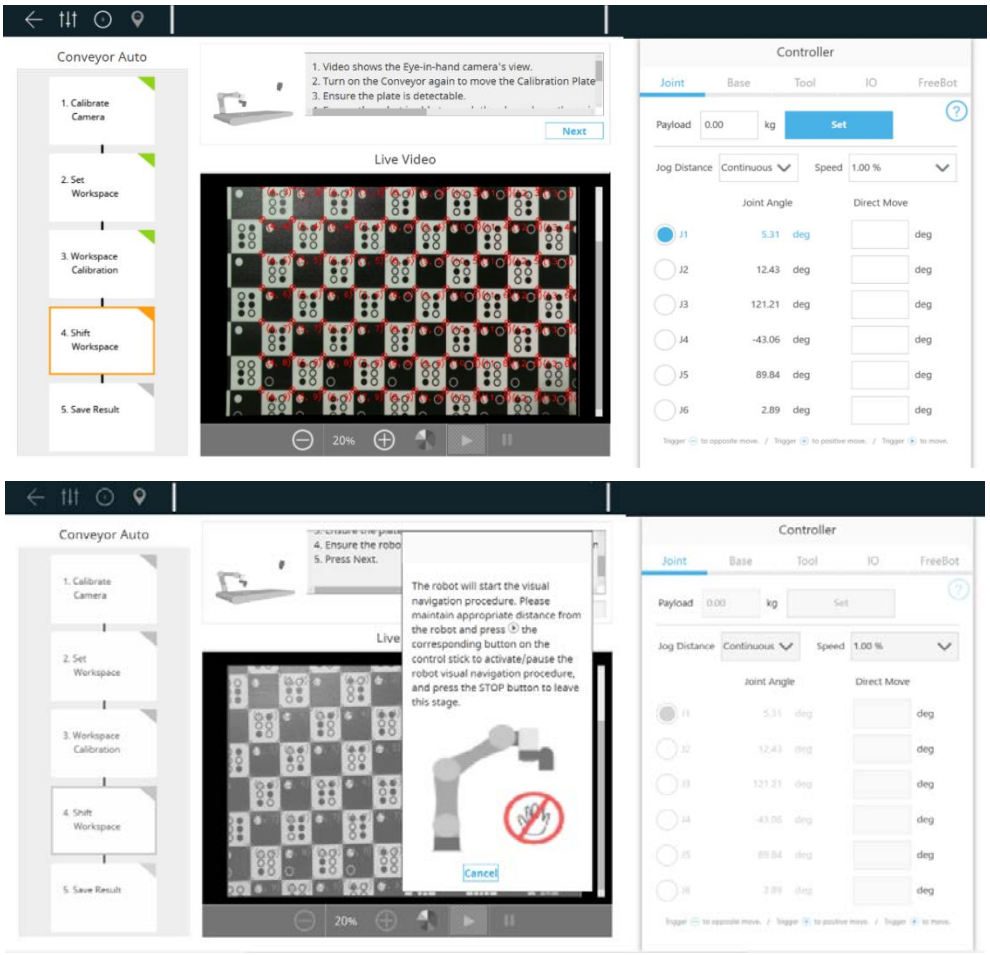
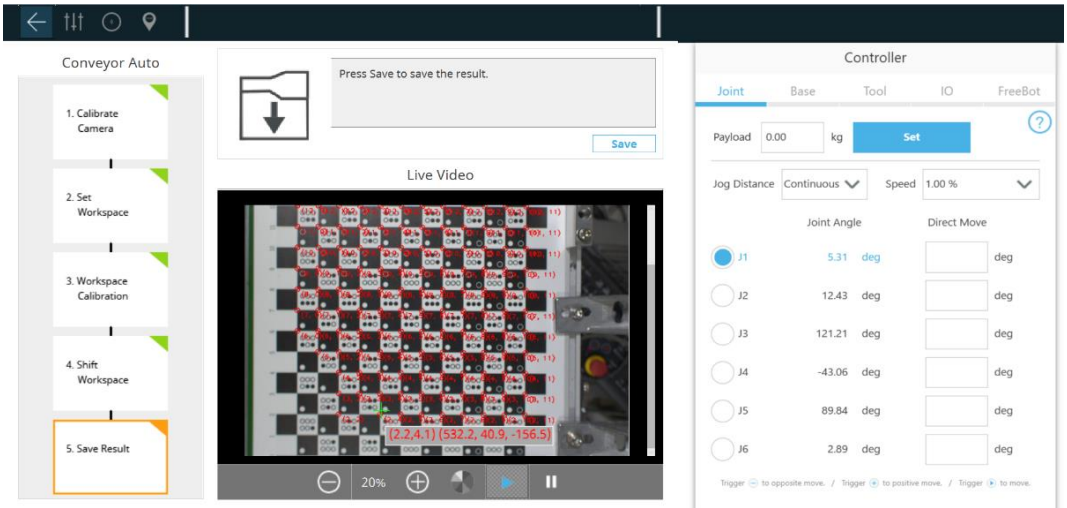


Figure 32: Shift Workspace

- **Save Result**: When the steps above are completed, click Save to save result and name the workspace.



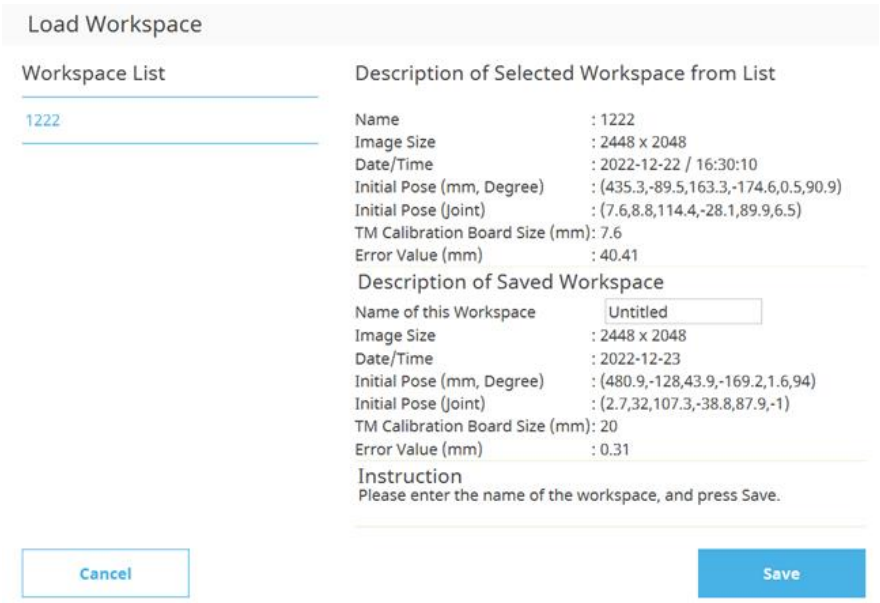


Figure 33: Save calibration result

3. Create a new Conveyor Tracking project

   A. Insert the TM Dongle into the control box before activating TMflow.

   B. Start a new project by clicking **New** > **New Flow** from the Project page in TMflow

   C. Check the Conveyor Tracking box

   D. Select the conveyor

      - Choose Conveyor_0 if 1 conveyor is used
      - Choose Conveyor_1 if 2 conveyors are used

   E. Select ETH Mode

Enter project name and click **Open**.

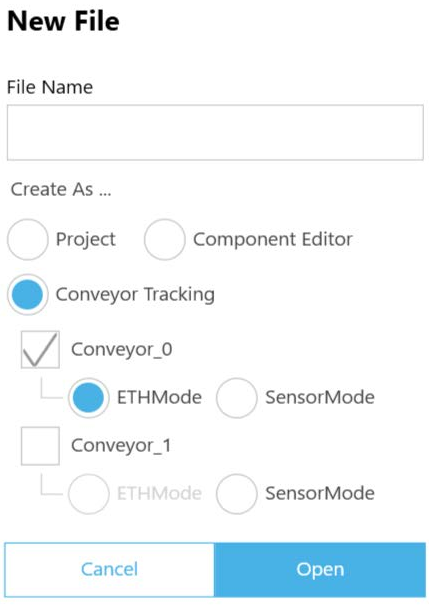


Figure 34: Open new project

4. Conveyor Tracking project appears

   This project come with two threads. One is the main thread for editing the robot motion process (the name is the project name), and the other is the sub-thread for the conveyor tracking setting (this thread is as shown in the figure below, which is for setting purposes only and users cannot add any node with it). Users can edit the main thread after editing the sub-thread.

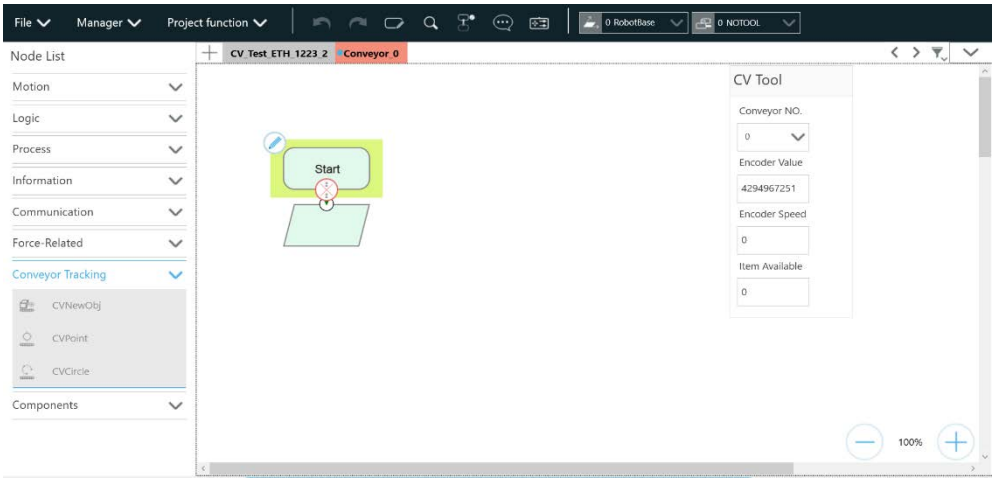


Figure 35: Sub-thread

5. Enter Conveyor Tracking Setting

   Click the pencil icon of the Start Node in the sub-thread to proceed with Conveyor Tracking Setting. Refer to **4.1** for details about sub-thread setting.

6. Once completed the settings, click the pencil icon of Vision Node and click **Select** next to the Vision Job to proceed vision job settings.

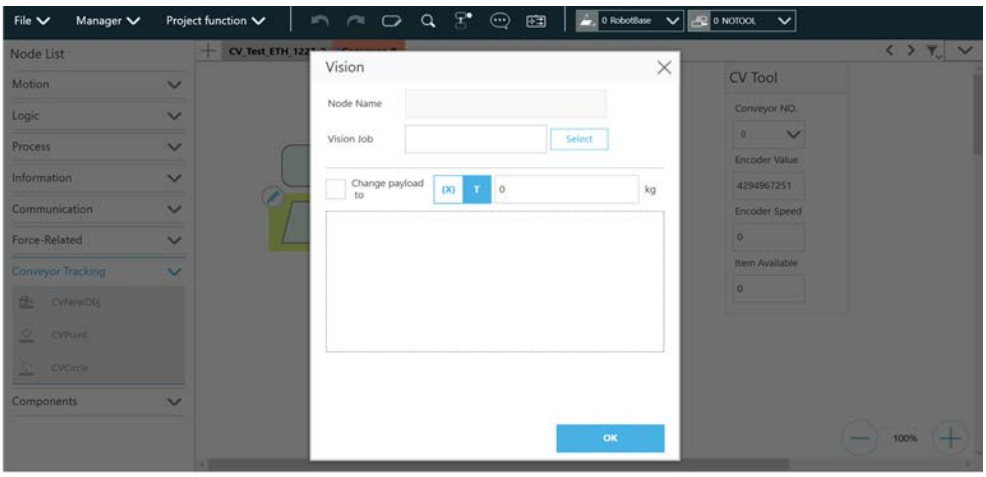


Figure 36: Vision Job

7. In the Vision Job, click the **+** icon and input the vision job name, and click **OK** to start new vision job.

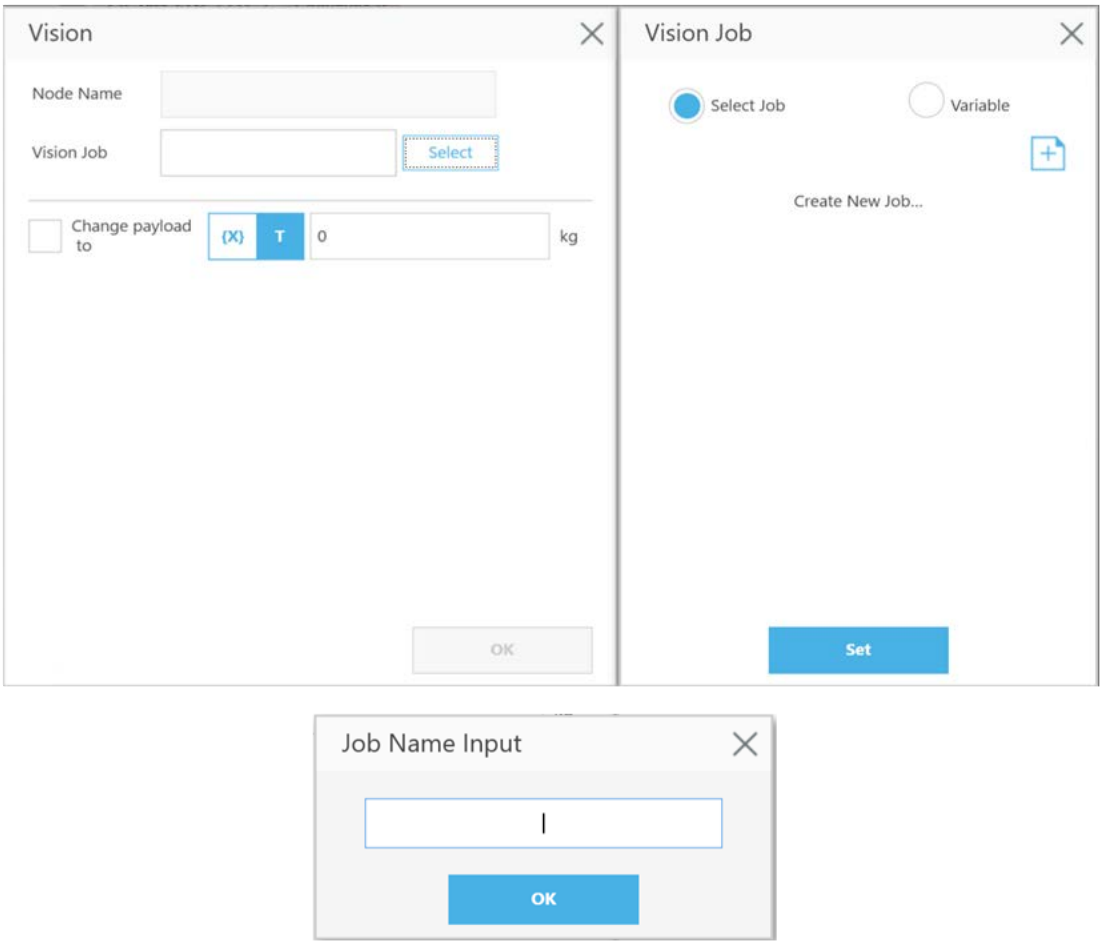


Figure 37: Input vision job name

8. Load Workspace

   A. Choose **Conveyor Tracking** camera, and click **Conveyor-tracking** in **Application Selection**.

   B. Choose a workspace from the **Workspace List**. Click **Load**.

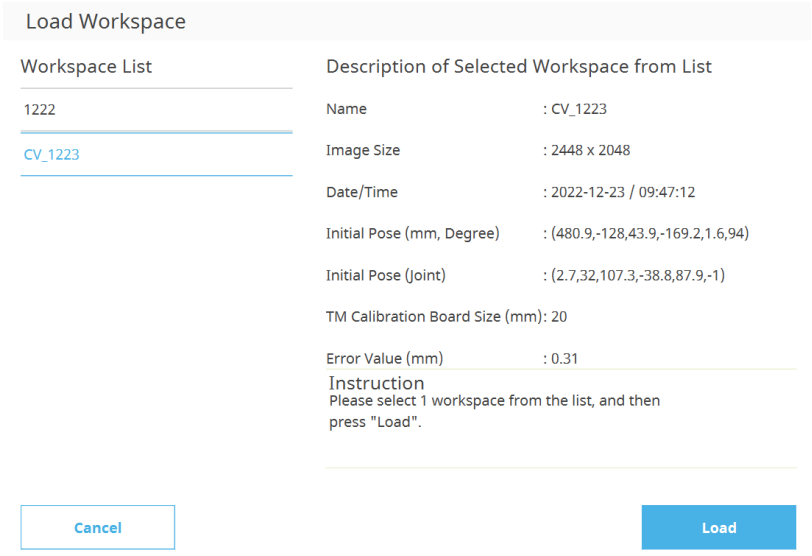
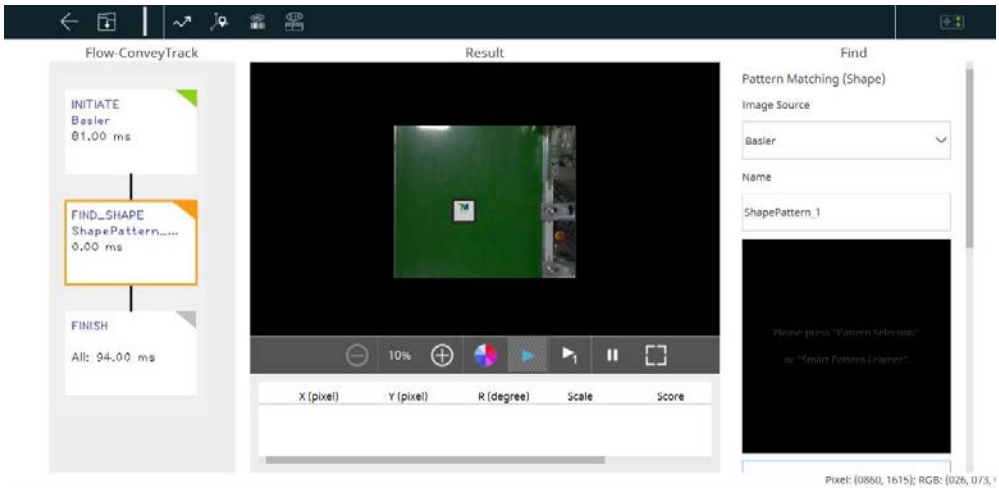


Figure 38: Load workspace

9. Place an object in the center of the vision area. Then go to  > **Pattern Matching (Shape),** and the robot will recognize the pattern and its range.



Click **Select Pattern** and select **Standard**. Hover the mouse cursor on the object in the image to decide the range of the pattern.

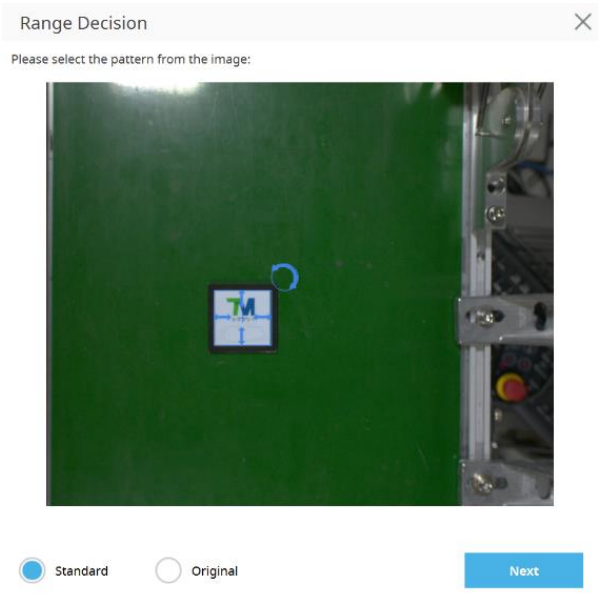


Figure 39: Pattern matching

10. Confirm the editing procedure
    A. Once the pattern recognition is completed, a set of positioning values is shown.
    B. The **FIND** shown in the editing procedure at the left is supposed to come with a triangle in green at top right. If the triangle is in **orange**, the pattern recognition is not completed.

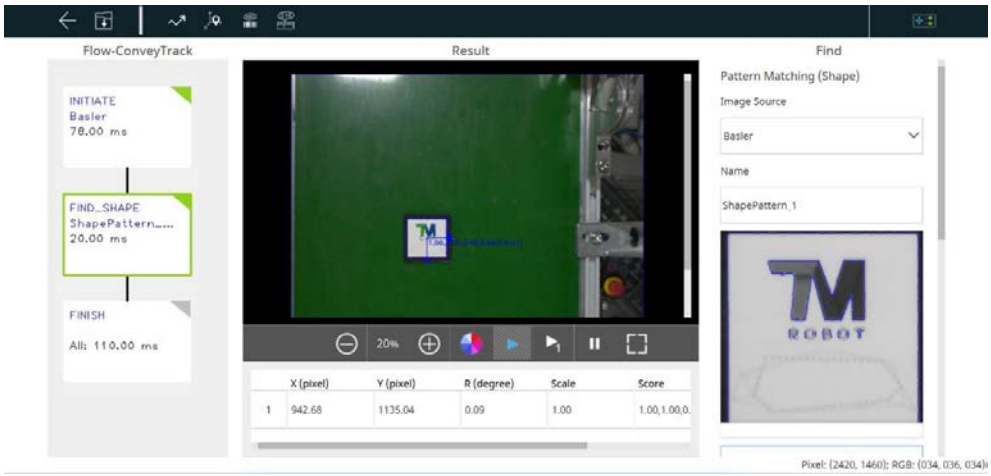


Figure 40: Confirm “FIND” pattern

11. Click  to save visual task, and input a name for the visual job.

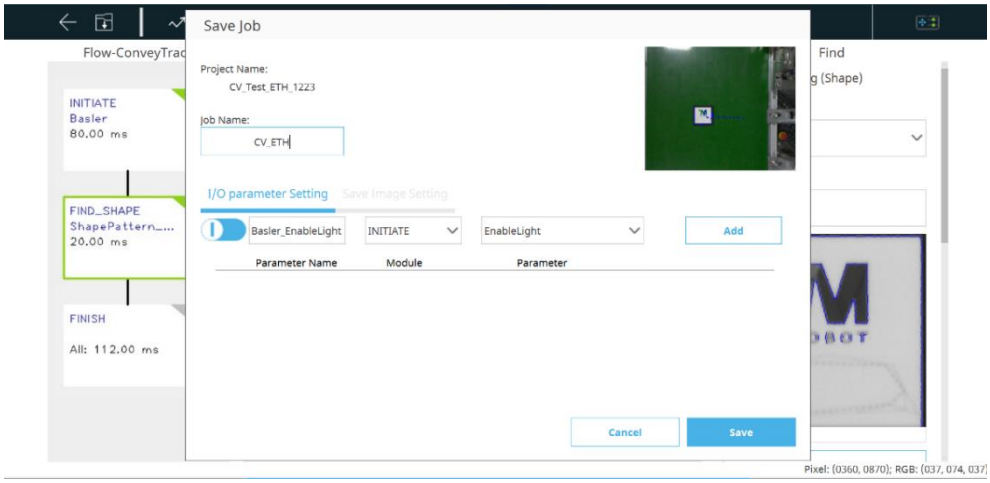


Figure 41: Save vision task

12. Back to TMflow and make sure the vision job edited just now is in the list of Vision Job. Click **Set** > **OK** to complete the setting.

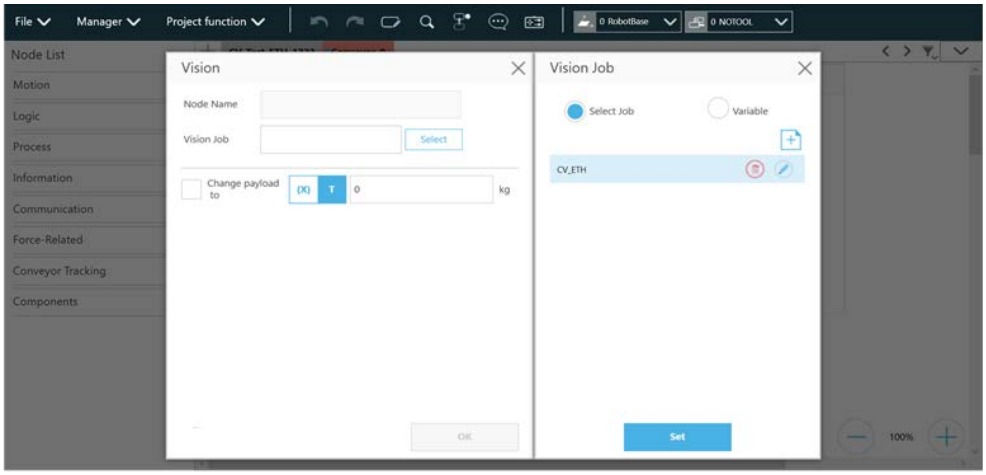


Figure 42: Check vison job on list

13. Switch to the main thread and select a tool for the project.

14. Drag a point node in the project editing page to set as the robot's initial work point.

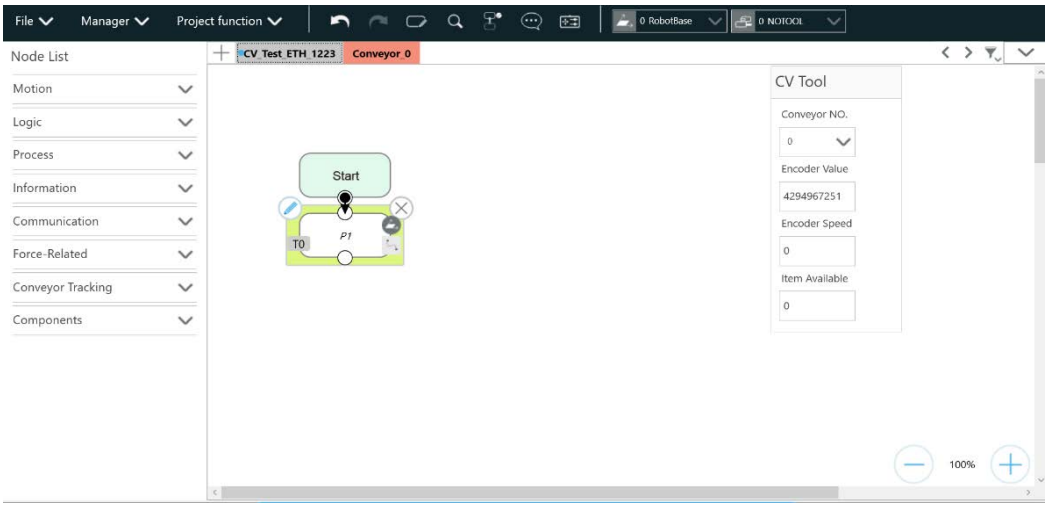


Figure 43: Point Node

15. Drag a CVNewObj node in the project editing page and choose the conveyor number.

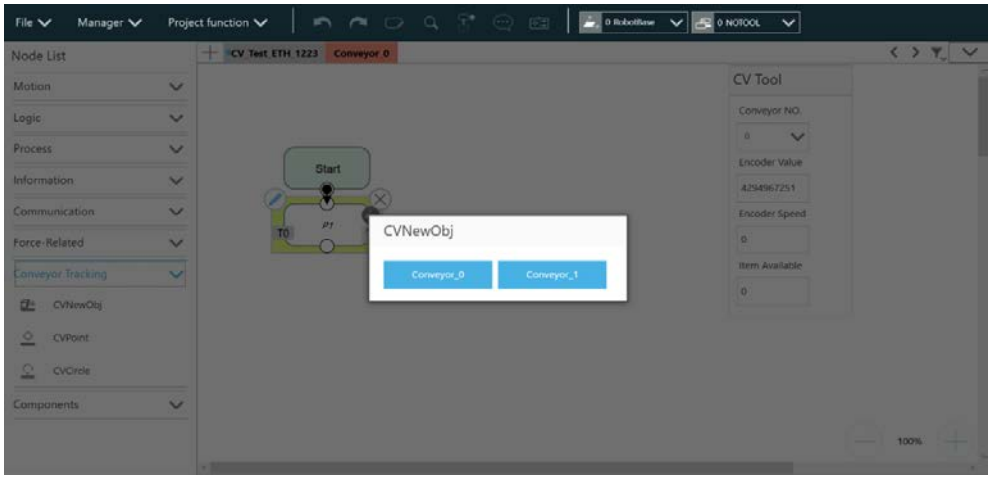


Figure 44: Select conveyor

Click the pencil icon of the CVNewObj node for the Time Out setting. For details, refer to **4.3.1.**

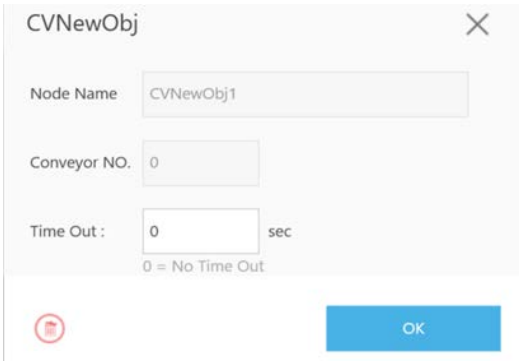


Figure 45: Set CVNewObj

16. Drag a CVPoint node in the project editing page and choose the conveyor number.

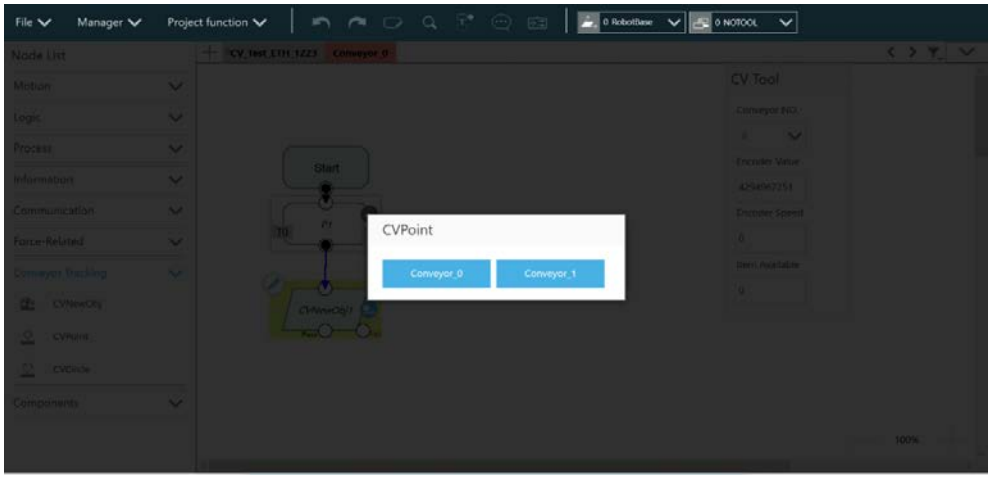


Figure 46: Set conveyor for CVPoint

Select **Pass Path**. Refer to **4.3.2** for details.

Figure 47: Set path

17. Enter CVPoint Node

A. Click the pencil icon of the CVPoint Node. Use the conveyor to move the object to the robot's working area.

B. Hand-guide the robot at the top of the object.

C. Click **Get Point**, click **Get**, and click **OK** to complete CVPoint setting in ETH Mode.

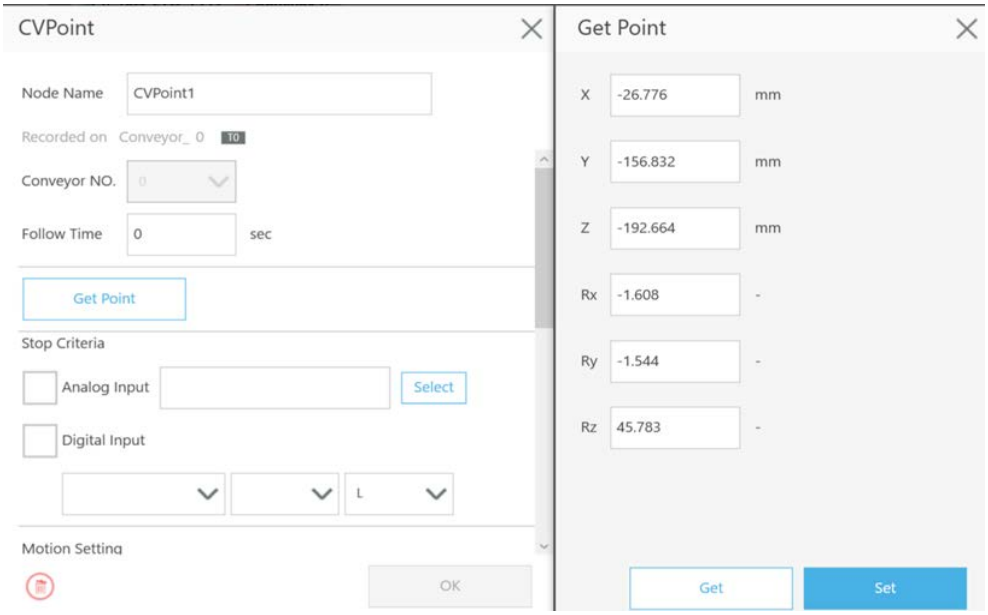


Figure 48: Get Point

18. Make the flow an infinite loop to form a simple object tracking process.

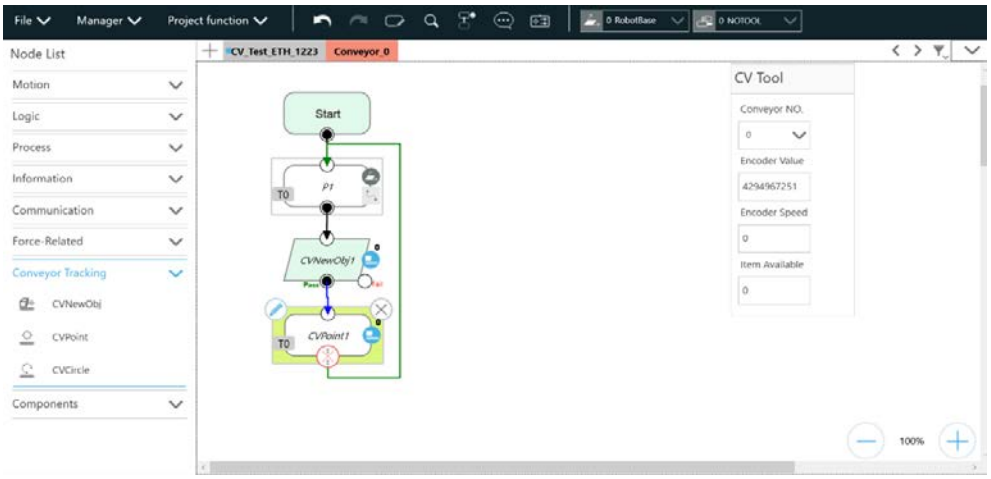


Figure 49: Form a loop

Note

NOTE：
Use either the advanced setting of gripping objects to go with the CVPoint's end tool I/O status and the point position setting or the output variables to go with Plug&Play software package to control the end tool to complete the gripping and releasing process.

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