TM

Conveyor Tracking

Software version: TMflow 1.68 and later

Document version: 1.00

Release date: 2018-10-01

Contents

Revision History Table

Revision	Date	Revised Content
1.00	2018-10-01	Original release

1. Introduce

1.1 Generality

TM Converyor Tracking can obtain the position and direction of the object using vision and sensor. It can implement high precise application to glue alignment, electronic assembly, loading and unloading. Futhermore, TM Converyor Tracking increases the efficiency of the production line.

When using the TM Conveyor Tracking function during TM Flow, place the TM dongle in the TM Conveyor Tracking product pack in any USB port in the control box to turn on the TM Conveyor Tracking function. Please note that when editing/trial run/operating, and the TM Conveyor Tracking function is to be used, keep the TM dongle on the control box.
Otherwise, editing cannot be done or the machine will stop.

1.2 Scope of use and limitations on use

1.2.1 Scope of use

a. One robot can be used for two conveyors.(Function limits ETH + Sensor, Sensor + Sensor).
b. Conveyor speed < 300 mm/s, average precision±1mm (when the workpiece angle variation within±15˚).

1.2.2 Limitations on use

a. Only supports one pick-up one put-down (Does not support ETH + ETH.)
b. Does not support two robots using one Encoder + EtherCAT IO
c. Only supports linear conveyor (Does not support circular conveyor).
d. Does not support multiple objects.

Remark
The precision specifications in this instruction manual are only for reference and guide purpose.Precision specifications and accuracy of calibration, environmental changes, workpiece changes,visual pattern edit quality, and conveyor stability are based on the completed automation unit,and other peripheral factors. Users should use actual test results as the standard.

2. Hardware requirements

The following introduces various hardware equipment required for erecting a TM Conveyor Tracking environment.

If labeled as “paired”, this means that the TM Conveyor Tracking can only be matched with this model equipment;

If labeled as “designated”, this means that the TM Conveyor Tracking can be matched with equipment similar to the specifications,

But if the user does not use the designated model, TM Robot is not responsible for its applicability.

If labeled as“recommend/reference” user must prepare on their own.

TM Robot will provide drawings/guide information to facilitate such preparation by the user.

2.1 TM Dongle (included in the product pack)

Used for activating conveyor tracking function.

2.2 EtherCAT Coupler + Encoder Module

Equipment name	EtherCAT Coupler	Encoder Module	EtherCAT Coupler	Encoder Module
Pair/designate	Pair		Pair	
Model	VIPA: 053-1EC00	VIPA: 050-1BA00	Beckoff: EK1100	Beckoff: EL5151/EL5152
Rated voltage	DC24V	DC24V	DC24V	DC24V
Rated current	950mA	75mA	570mA	130mA
Note: Equipment needs to be connected to external power supply to use. For detailed product information, please visit the product’s official website.				

2.3 Encoder (TM Conveyor Tracking designate encoder model)

Equipment name	Encoder
Pair/designate	Designate
Model	Omron E6C3- CWZ5GH 2000P/R 2M
Rated voltage	DC12 to 24V
Rated current	100mA
For detailed product information, please visit the product's official website.	

2.4 Code wheel

Reference specifications: circumference 300 mm (diameter 95.54 mm)

Related design drawings of Encoder Kit can be downloaded from TM Robot's official website customer area.

Please confirm that the code wheel is flat against the conveyor, and will not slide around turn when turning.

2.5 Camera

Equipment name	Camera		
Pair/designate	Pair		
Connection interface	GigE interface		
Model	Global shutter	Global shutter	Rolling shutter
	Basler acA2440-20gc (colored 2/3 inch sensor)	Basler acA2500-20gc (colored 1 inch sensor)	Basler acA2500-14gc (colored 1/2.5 inch sensor)
Remark	When conveyor speed < 300 mm/s, the average error is ±1 mm.	When conveyor speed < 300 mm/s, the average error is ±1 mm.	Rolling shutter camera is recommended to be used at low speed (conveyor speed < 100 mm/s) and when precision requirement is lower.
For detailed product information, please visit the product's official website.			

2.5.1 Lens

Please use an industrial-specifications C/CS Mount lens. The lens focal distance should be chosen according to the actual applied work distance.

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

Reference 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.

2.6 Light source set-up reference guide

To obtain good image quality and rapid imaging time, we recommend that the image field light source intensity reaches 2500 Lux; uniformity should be higher than 90% to avoid light reflection.
If the lighting cannot reach 2500 Lux, the camera's exposure time must be increased, which will decrease the conveyor speed.

For example (when the camera's focal object is 500 mm):
Light intensity is 2500 Lux, exposure time setting is 0.5 msec, and the conveyor speed is 300 mm/sec;
When light decreases, the exposure time needs to increase and the conveyor speed must be decreased to avoid blurring the object.
Uniformity calculation method:
Cut the camera field into a 3 x 3 grid as in the following figure. Measure the brightness in the center of each grid and obtain the maximum and minimum value,
Then substitute:

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

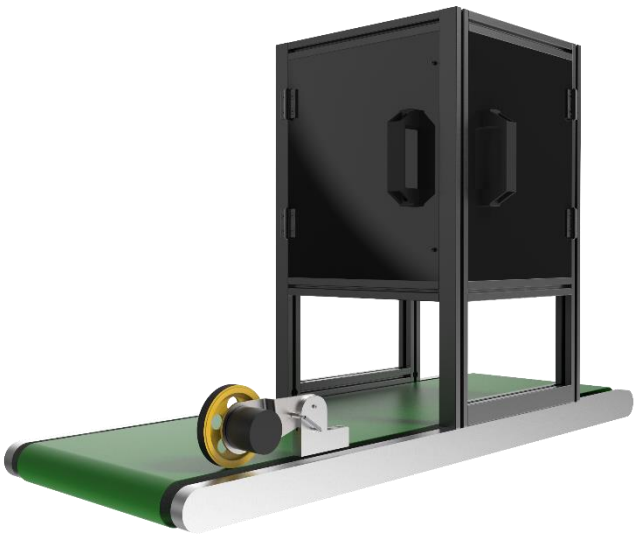
2.7 Sensor

Please choose the most appropriate sensor according to the object material that needs to be detected. When using SensorMode, we recommend adding the official TM Robot Calibration Set expansion accessory for positioning. When setting CVPoint is required, switch back to the required tool.

Note: To purchase TM Calibration Set, please inquire with TM Robot

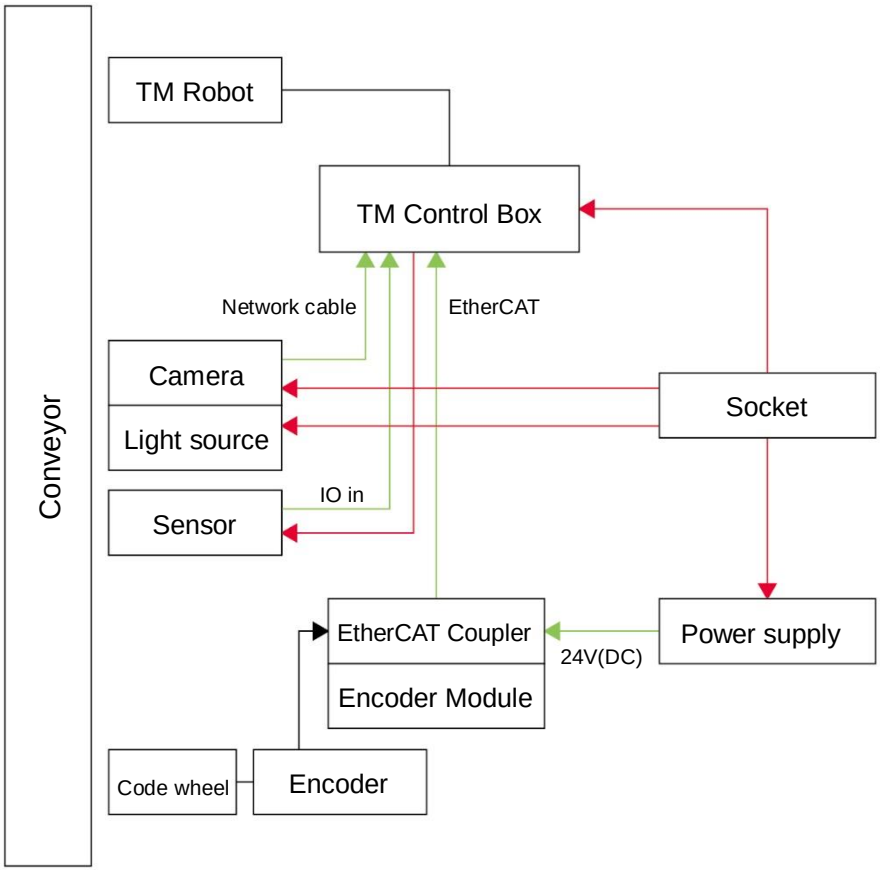
2.8 Light box design reference

Related design drawings can be downloaded from TM Robot's official website customer area.



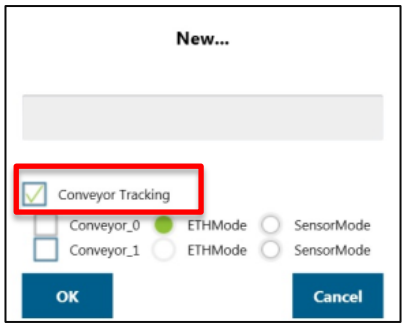
2.9 Hardware connection

Please connect the hardware modules according to the following figure.



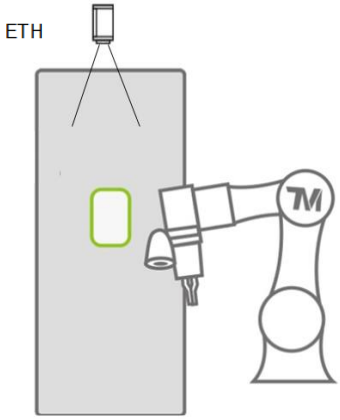
3. Operating mode

The user creates the new project (must insert the TM dongle) and selects Conveyor Tracking on the checkbox to generate the related projects. TM Conveyor Tracking supports two modes, the first is ETHMode (use external camera to obtain image) and the other is Sensormode (detect objects by sensor). Choosing the Conveyor_1 can implement two converys tracking, but it can only support ETH+Sensor or Sensor+Sensor. The ETHMode and Sensormode will be introduced as following:



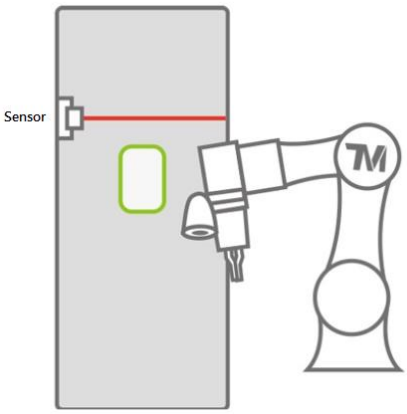
3.1 ETHMode

ETHMode is made up of a robot, external camera, and light source. The schematic of the ETHMode presents as shown in below:



3.2 SensorMode

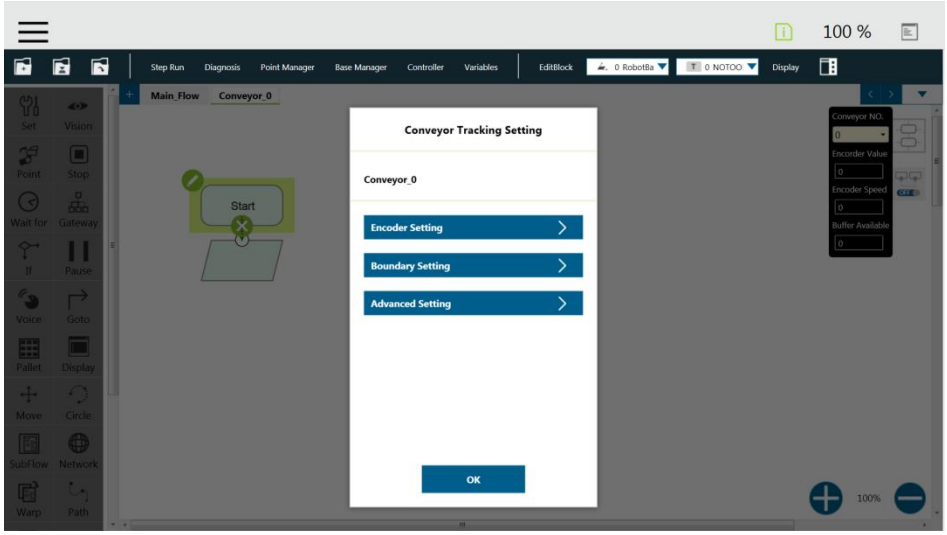
SensorMode consisted of a robot and external sensors. The schematic of the SensorMode presents in below:



4. Software function introduction

4.1 Conveyor Tracking Setting

After opening the Converyor Tracking project, selecting the Start Node can set parameters of the encoder, working boundary, cameras and conveyor. Advance description will be shown as below:



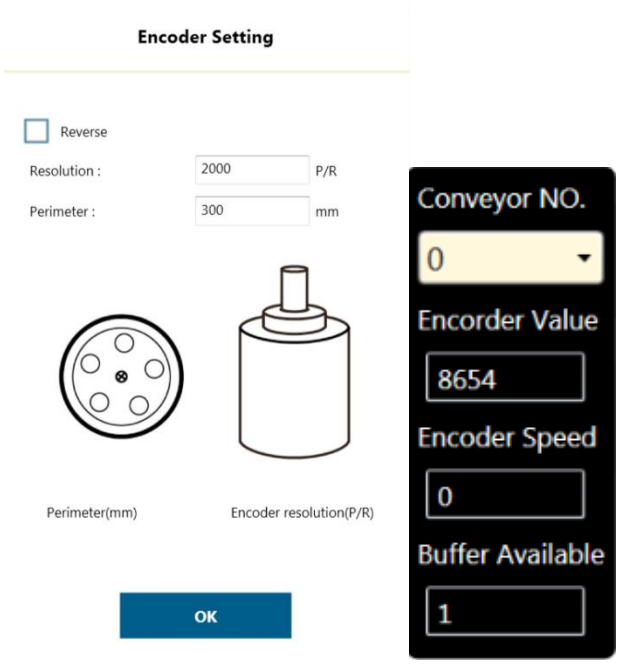
4.1.1 Encoder Setting

The description of the Encoder Setting is as follows:

Resolution: Encoder resolution.

Perimeter: code wheel circumference (mm).

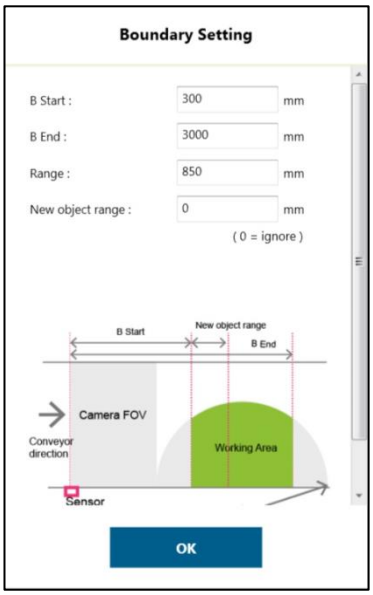
Reverse: (Reverse rotation): when the conveyor is operating, the speed indicator should be positive; otherwise, please select Reverse .



The officially designated encoder model is the Omron E6C3- CWZ5GH 2000P/R 2M. MActual settings still require the user to select the model setting.

4.1.2 Boundary Setting

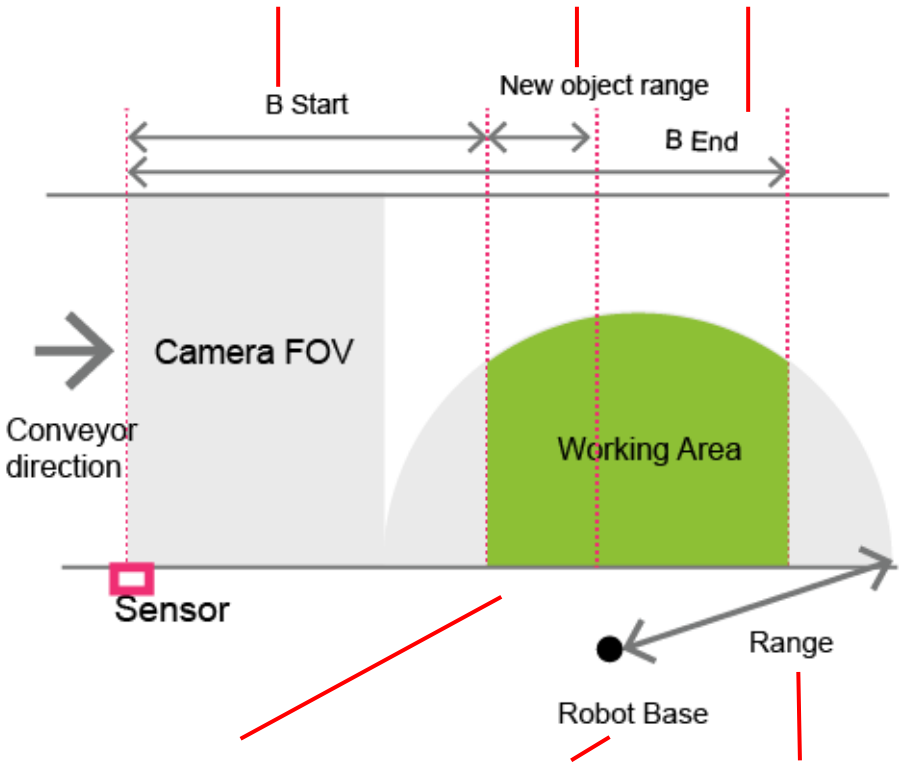
The Boundary Setting can set related parameters of working zone. The meaning of each parameter is explained as below.



B Start: Work starting point

New object range: Select object range.

B End: Work end point



Working Area: Actual work range.
Follow the intersection produced by range, B Start, and B End. If there is no intersection (such as B Start setting is small or B End setting is very big), directly use the distance of the range for determination.

Robot Base: Robot placement position.

Range: Robot work range
Recommend a maximum of 650 mm (700 model)
Recommend a maximum of 850 mm (900 model)

4.1.3 Advanced Setting

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

Camera offset (ETH only)

Camera calibration parameter adjustment can be used to fine-tune the object grab error and adjust identification result.

u offset (mm): when adjusting calibration, the calibration plate x direction error.

v offset (mm): when adjusting calibration, the calibration plate y direction error.

Angle offset (degree): when adjusting calibration, the calibration plate xy axis angle error.

repeat protect (mm)：The protection of object repeat detection, please take the "Buffer Available" into consideration.

If the single object were being detected as multiple objects,please increase the value of repeat protect.

On the contrary, if the multiple were being detected as single object, please decrease the value of repeat protect.

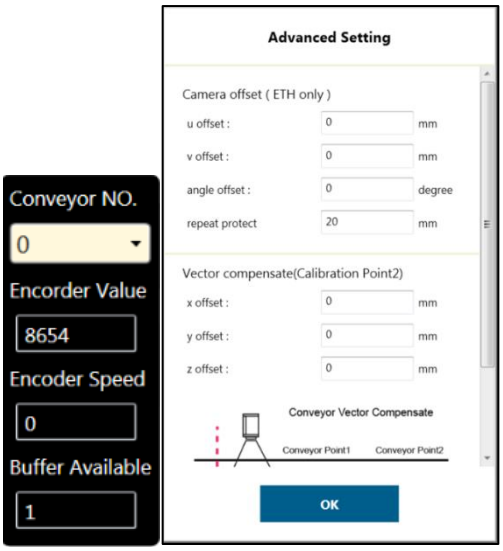
Vector compensate (Calibration Point 2)

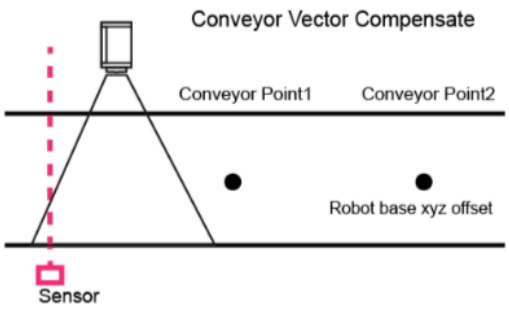
Conveyor vector compensation is for correcting the robot base coordinate value (x, y, z) of calibration point 2.

x offset: correcting the x coordinate of the robot base.

y offset: correcting the y coordinate of the robot base.

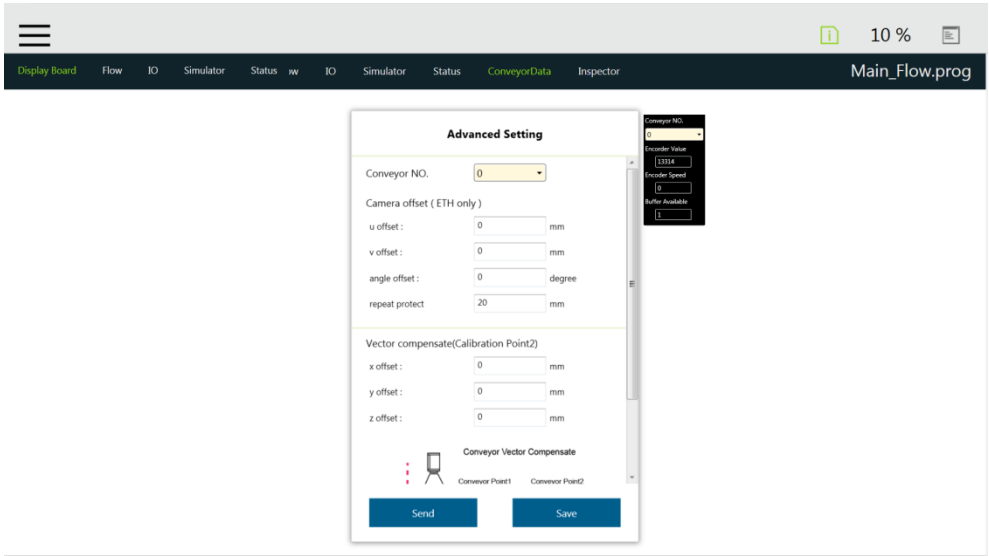
z offset: correcting the z coordinate of the robot base.





Note: Advanced setting can be adjusted online on the conveyor data page after

Advanced setting does not support switching in warp switching cases. If a case uses Warp Node, please use Warp Node as the connection after adjusting the advanced setting.



4.2 Node

4.2.1 CVNewObj Node

The following is the CVNewObj Node setting introduction.

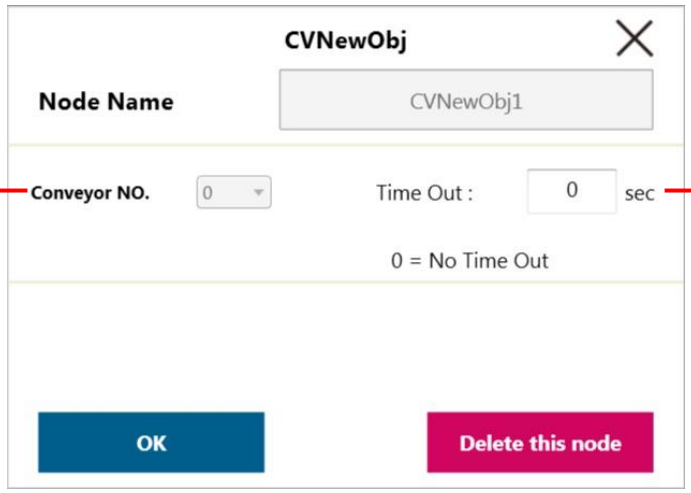
Conveyor NO: Conveyor number

Timeout: Set the valid object time within the waiting operation range.

(Fail: is the timeout path)

Pass Path: When the valid object time is smaller than the timeout time in the waiting operation range, update object and wait for object to enter the operation range.

Fail Path: When the valid object time is greater than the timeout time in the waiting operation range, this Node will guide to this Node's exit. You can use this Node's exit to edit the error handling behavior that you require.



[Conveyor NO]
Conveyor number.

[Timeout]
Setting the valid object within the waiting operation range.

[Pass Path]
Update object, wait for the object to enter operation range.

[Fail Path]
Valid object time is greater than the timeout in the waiting operation range. (Fail is the timeout path.)

4.2.2 CVPoint Node

Function: Line movement under the conveyor mode. Can be viewed as an object moving point that tracks the conveyor movement.

> **Note:**
> When in ETHMode, the tool end will turn with the object.
> When in SensorMode, the tool end will not turn with the object.

The following is the introduction to CVPoint Node setting:

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

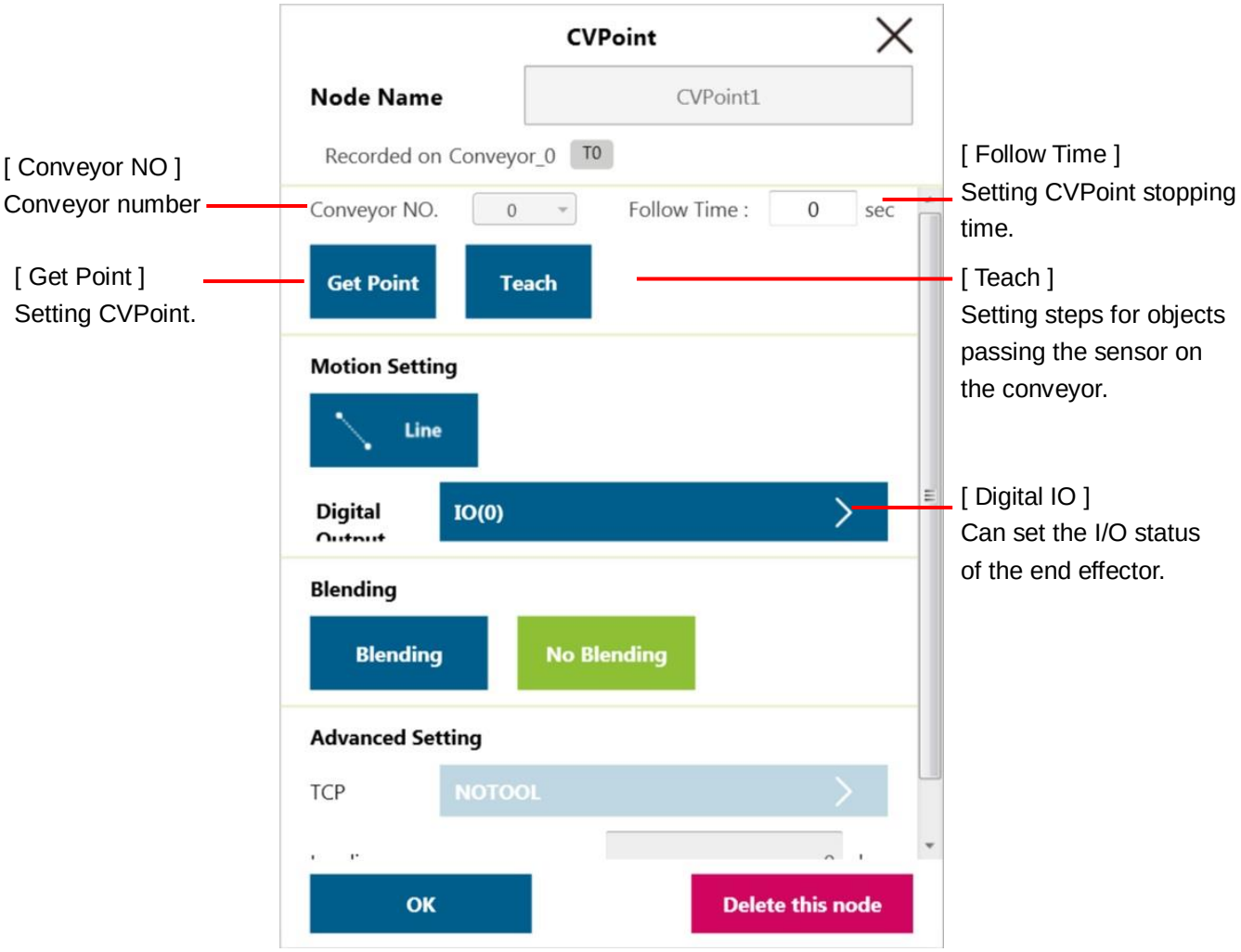
> **Note:** If the object has not been removed, setting of sensor CVPoint and CVCircle does not have to be re-taught.

Conveyor NO: Conveyor number.

Get Point: Please set CVPoint above the object.

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

Digital IO: Robot tool end's end effector is the End Module_DO 0.



Note: Methods for re-setting the robot and object's corresponding relationship:

ETHMode: Please put object placement under the ETHCamera. Return to the sub-thread's vision to look at the object again. After storing, get one more time.

Reminder: **When changing the encoder, please edit a new visual task in the sub-thread'svision after setting the encoder.**

SensorMode: Please use conveyor to move the object pass the sensor to complete teaching after pressing the CVPoint teach and before object placement's sensor point.

Reminder: **When changing the encoder, please return to sub-thread to directly reset sensor**

The following is the GetPoint function introduction in the CVPoint Node:

Get: automatically obtains the identification point's corresponding position value above the tool and object. Click OK after value has been obtained.

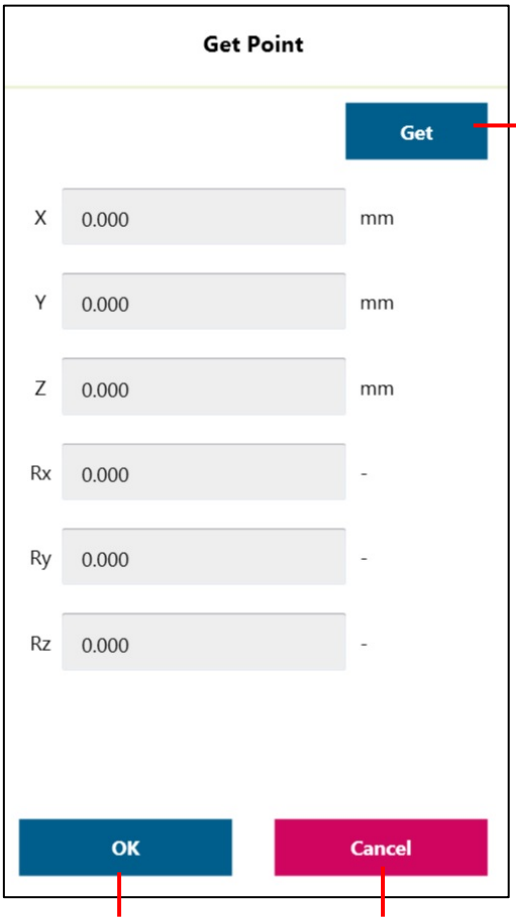
> **Note:** When the x, y, z values are not reasonable, the Get point is wrong. Please reset.

OK: Stores result and return to the previous page.

> **Note:** If the case already has CVPoint Node that has passed Get value, value can be inputted directly to make changes for new CVPoint Nodes in the future. Just click OK after input is complete.

Cancel: Cancels any changes and return to the previous page.

Other CVPoint Node setting is the same as the point node.



[Get]
Automatically obtain the identification point corresponding position value above the tool and object. Click OK after value has been obtained.

[OK]
Store result and return to the previous page.

[Cancel]
Cancel any changes and return to the previous page.

Note: IO setting is before the implementation of Follow Time.

Multiple CVPoint Nodes can be used with digital IO of end effector status setting to complete the grab procedure editing.

4.2.3 CVCircle Node 

Function: Circular motion under the conveyor mode is an arc movement the moves with the object on the conveyor.

The following steps are operation procedures.

Teach: Steps for using conveyor to pass object over the sensor.

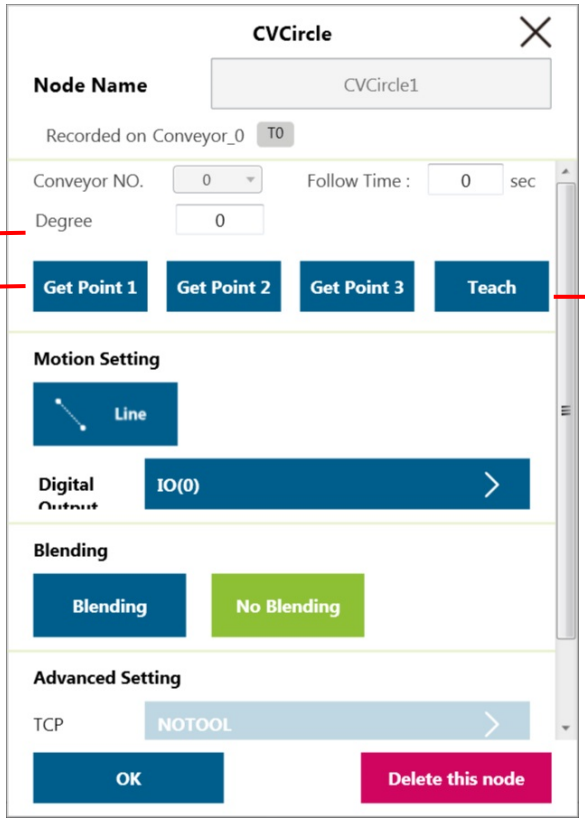
Note: If the object has not been removed, setting of sensor CVPoint and CVCircle does not have to be re-taught.

Degree: Set the movement path circular angle according to the established arc.

Get Point: Set CVCircle point. (P1 starting point, P2 midpoint, P3 end point) setting method is the same as for the 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.

[Degree]
Set the movement path circular angle according to the established arc.

[Get Point]
Setting CVCircle point. (P1 starting point, P2 midpoint, P3 end point)



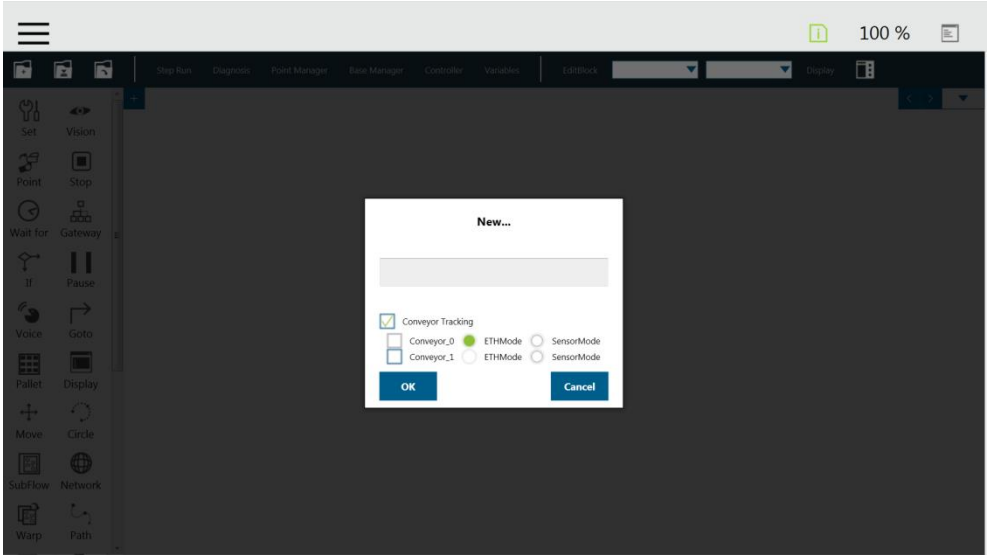
[Teach]
Setting steps for objects passing the sensor on The conveyor.

5. Quick start guide

5.1 ETHMode introduce

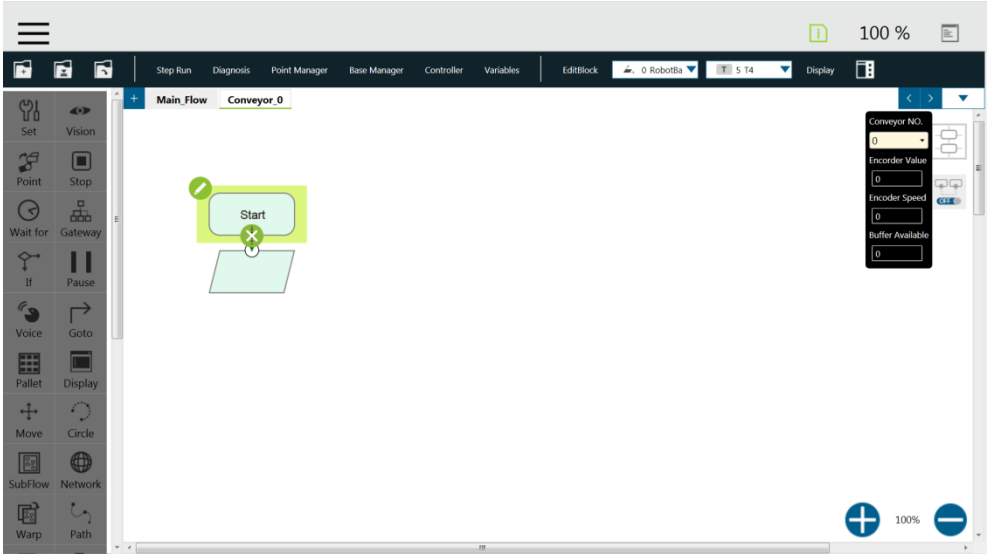
Step1

Enter the project of left side function menu, and then click on the top left corner icon to add new case. After selecting the Conveyor Tracking, choose the needed mode to proceed with case editing. Select Conveyor Tracking. Select ETHMode. Start editing the Conveyor Tracking ETHMode.



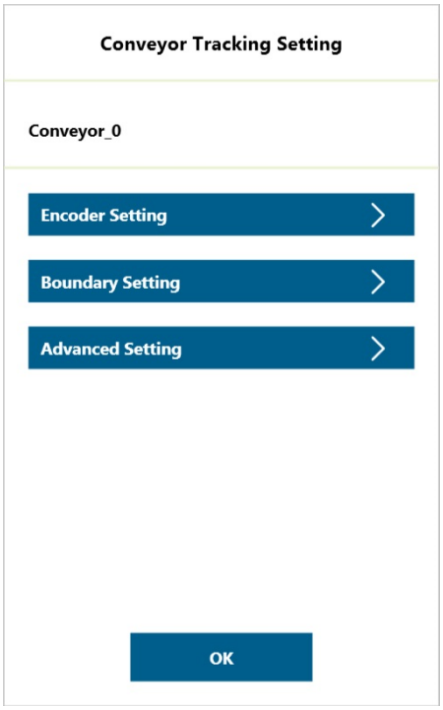
Step2

Two threads will appear. One is the main thread for editing the robot movement procedure (called Project Name) and the other is purely a sub-thread for adjusting Conveyor Tracking settings (this thread cannot add any Nodes and is only for setup purposes). The sub-thread must be edited before the main thread can be edited.



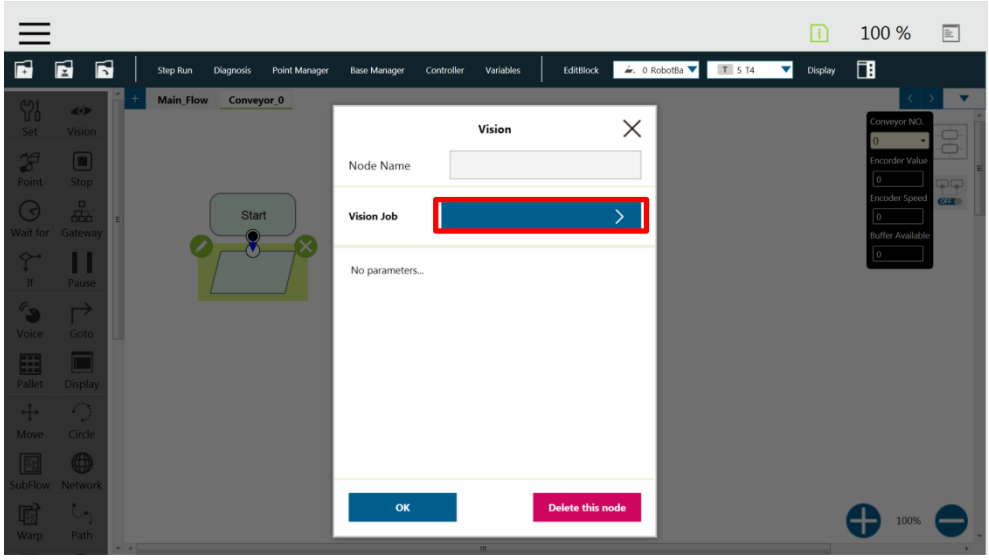
Step3

Click the sub-thread's Start Node to proceed with Conveyor Tracking setting. For information on setting related functions, please reference Chapter 4 Software function introduction.

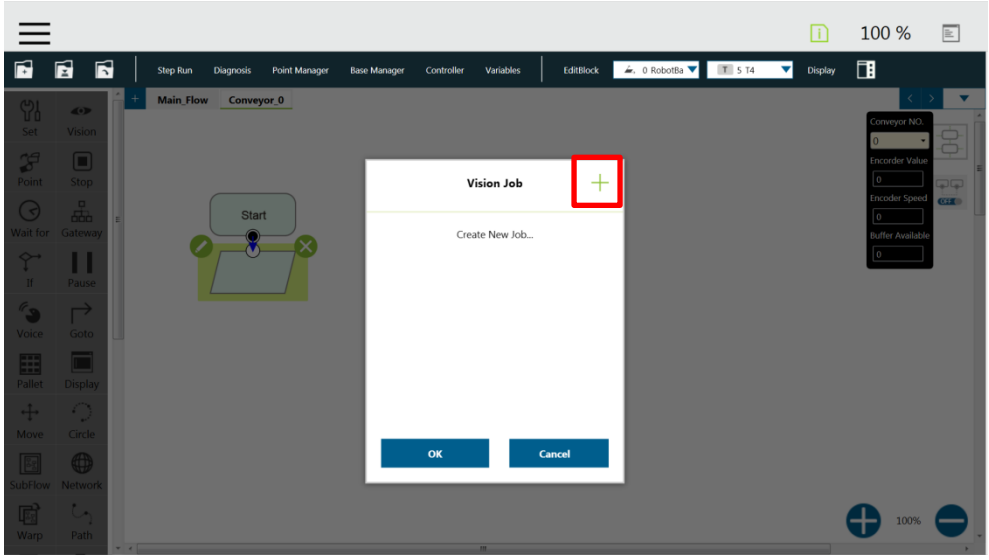


Step4

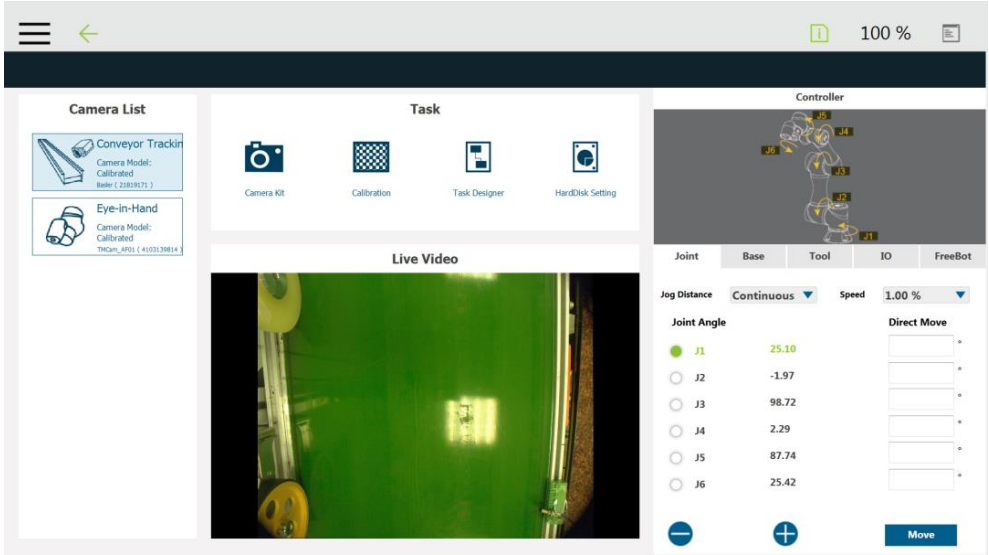
After completing the Start Node, click the Vision Node , then click the Vision Job's right side blue frame to proceed with vision related settings.



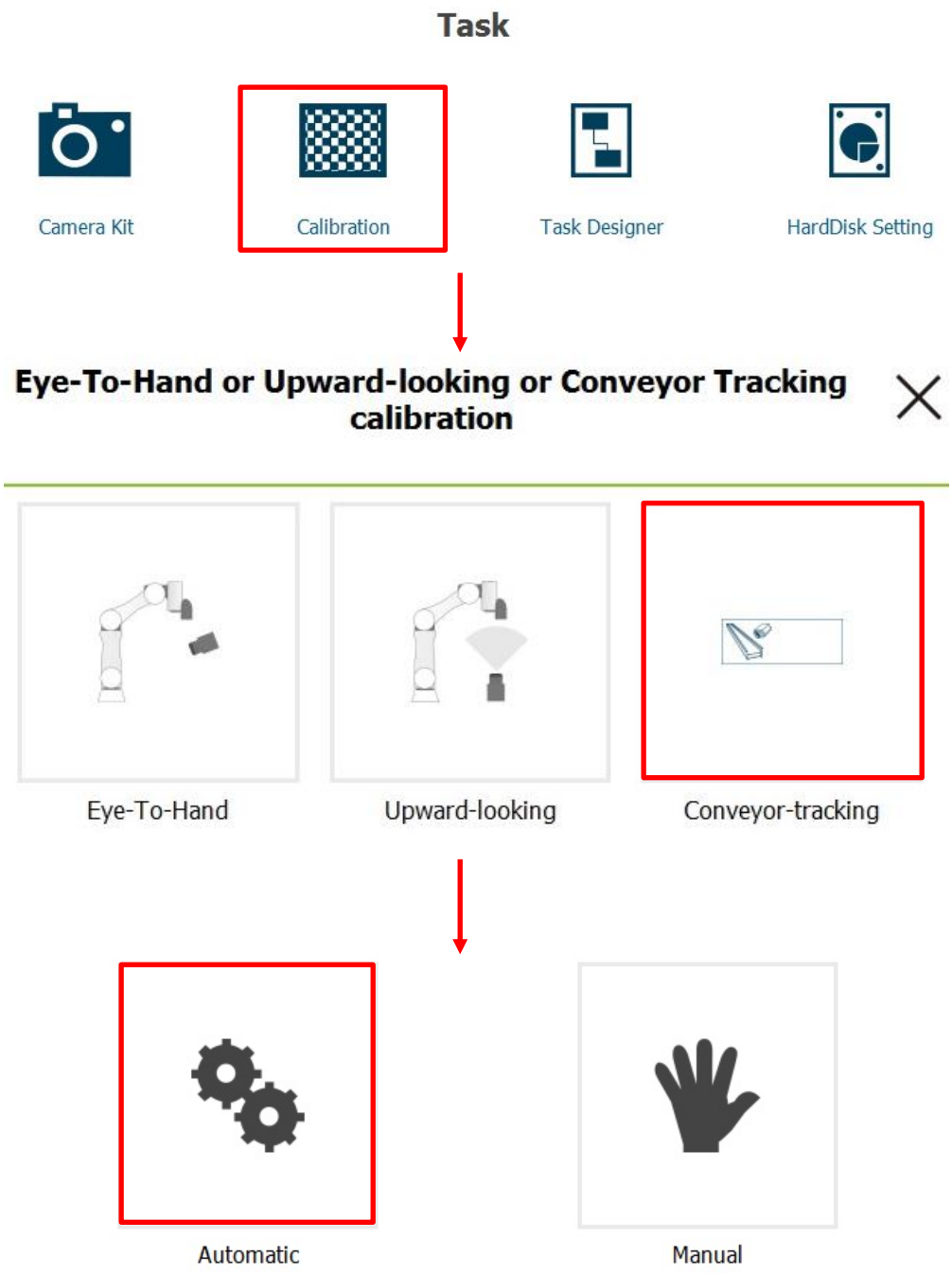
Step5 In the Vision Job page, click + and input the vision task name.Then click OK to start new vision task.



Step6 After entering the vision screen, choose hand-eye relationship as the conveyor tracking camera in the left side camera list. (example screen is the calibrated screen)



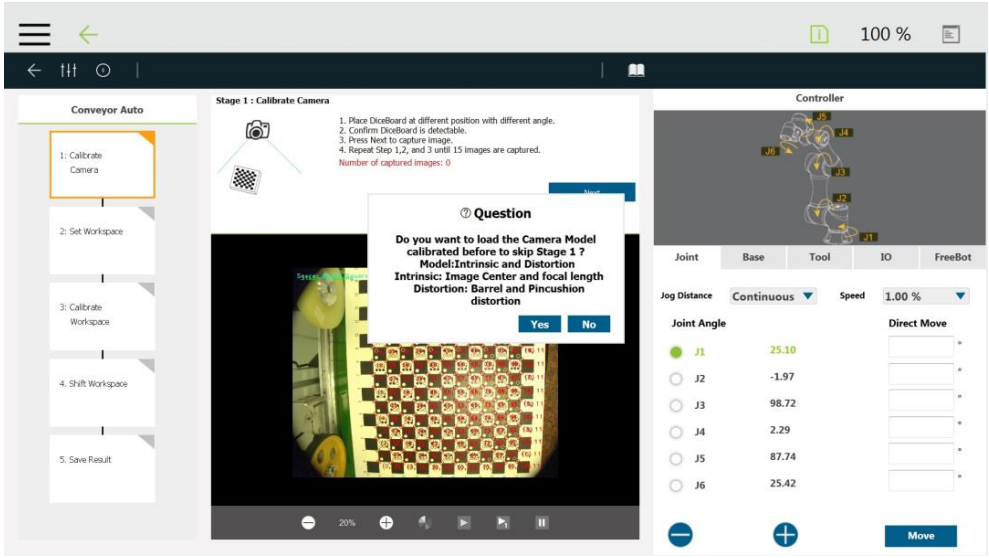
Step7	Click camera calibration, choose conveyor tracking, then choose automatic or manual mode to enter the calibration screen.



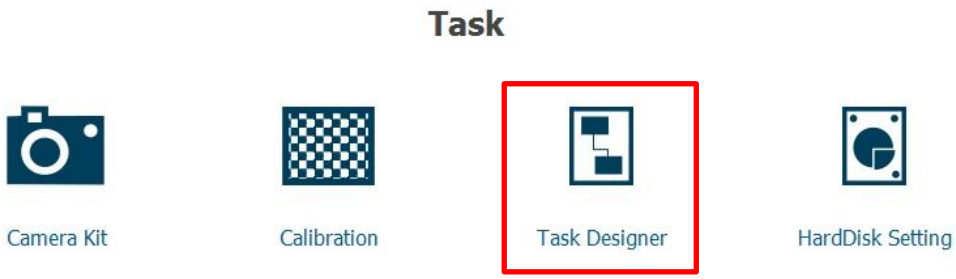
1. **Camera calibration:** make sure to check after taking 15 pictures that the screen is not twisted (use the calibration plate to check this)
2. **Set Workspace:** It is recommend that the x axis be in line with the conveyor direction and that the y axis (0, n) stick to the edge of the screen. (same for automatic and manual)

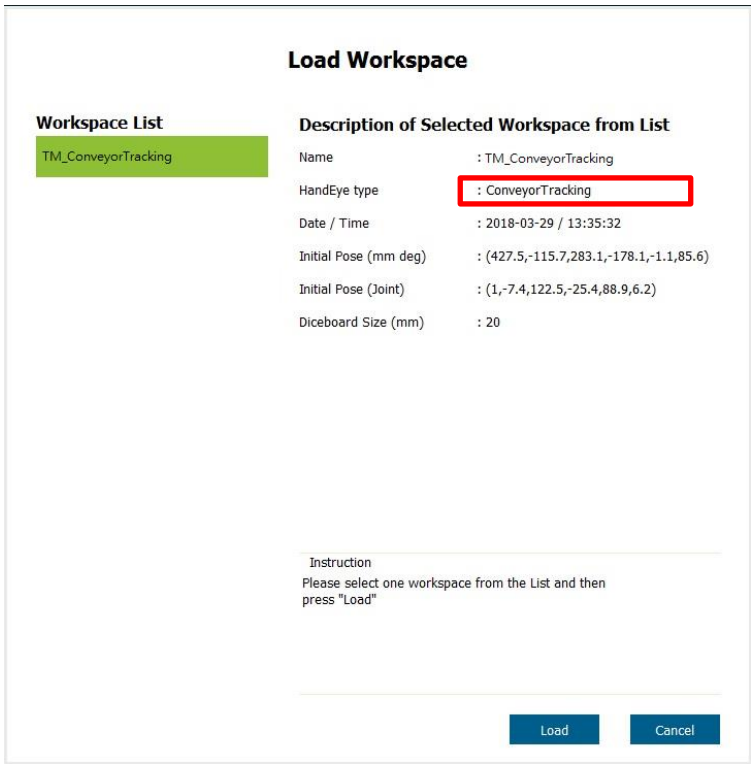
   If the camera is not calibrated, please press No and enter the first step: Camera calibration.

For further steps, please follow the description shown on the screen.

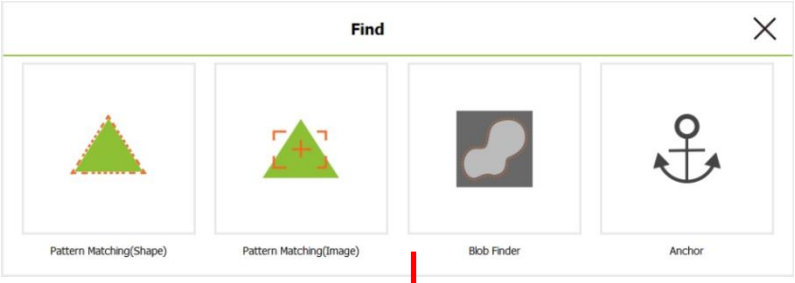


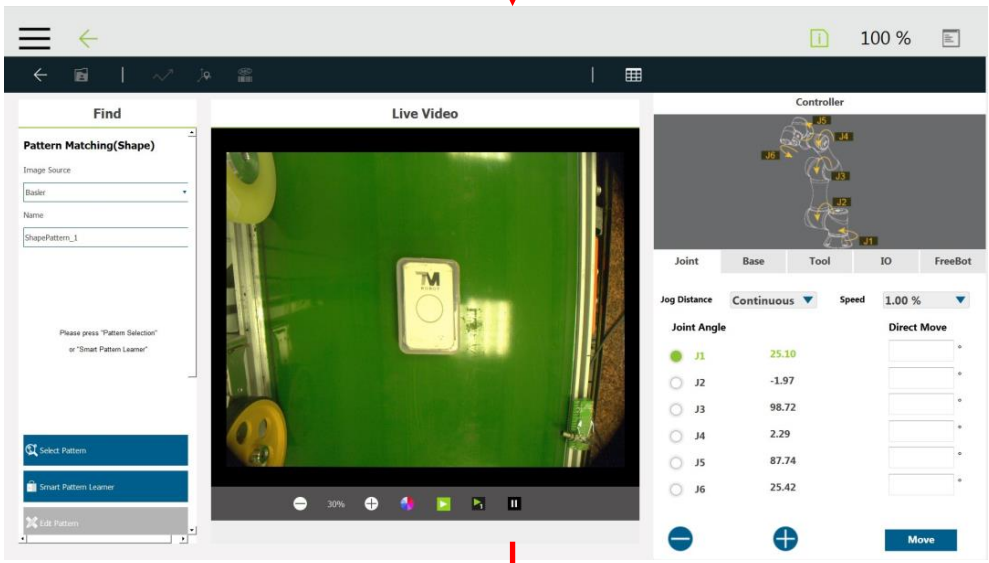
Step8	After camera calibration is complete, click Task Designer. Choose the required Workspace (make sure the hand-eye relationship is ConveyorTracking). Click Load button.

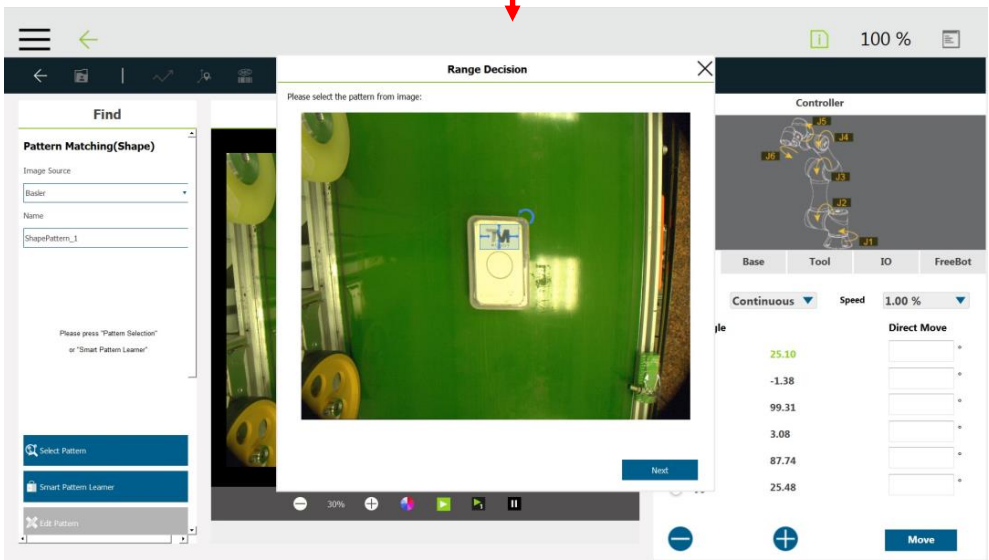




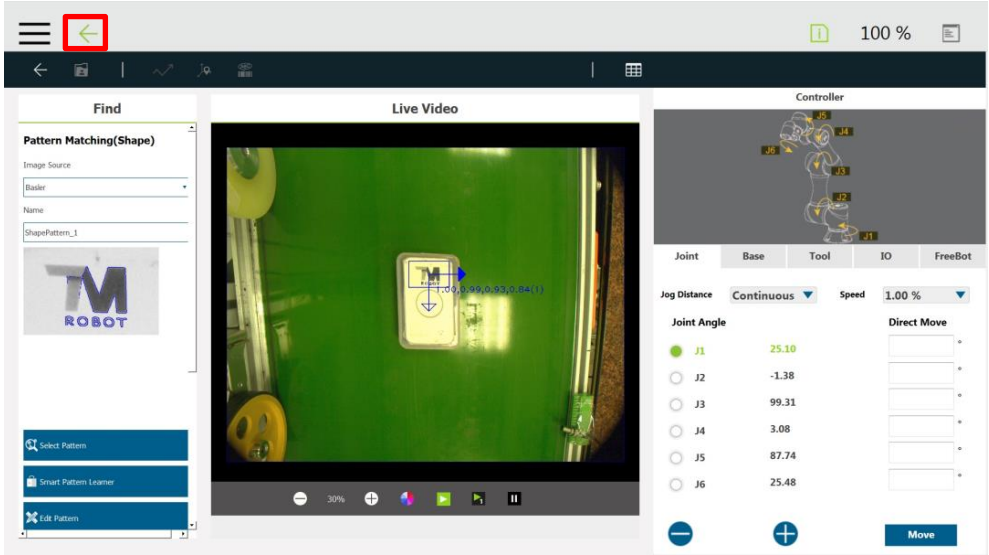
Step9	Put object placement in the center of the image. Click  and choose the object detection method to be used (here, describe according to Pattern Matching (Shape)). Then click select pattern and frame select the required pattern.



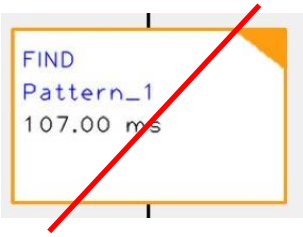




Step10 After frame selecting the pattern and confirming that the score is stable, click ← on the upper left side.



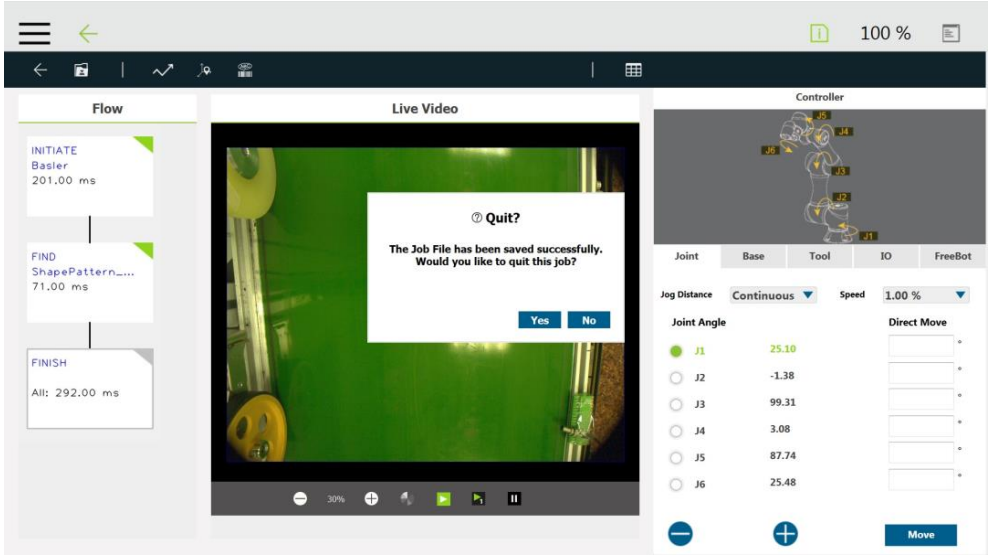
Step11 The left side editing procedure will have an extra FIND (green).



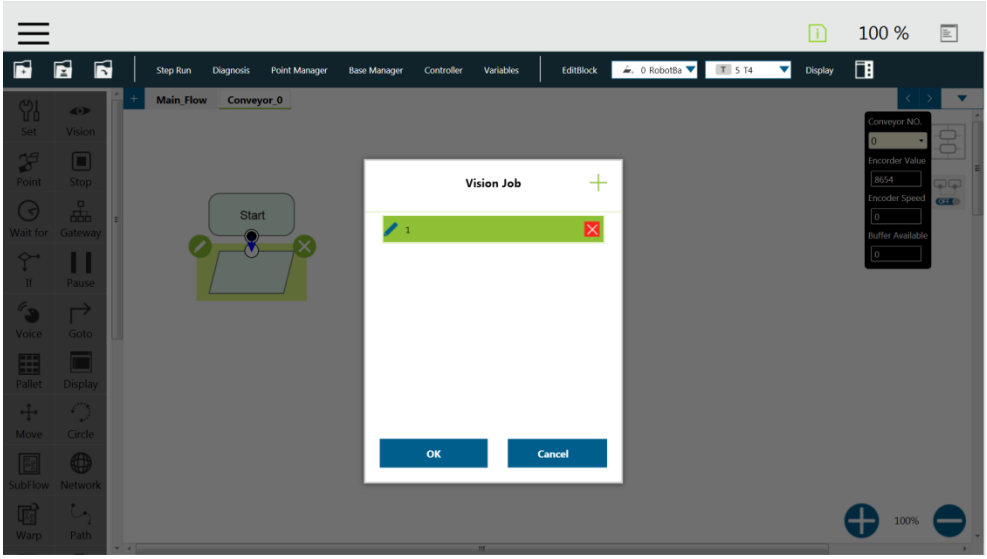
FIND cannot be orange.

Note: FIND cannot be orange. Orange means that the pattern score is too low or the field has no object.

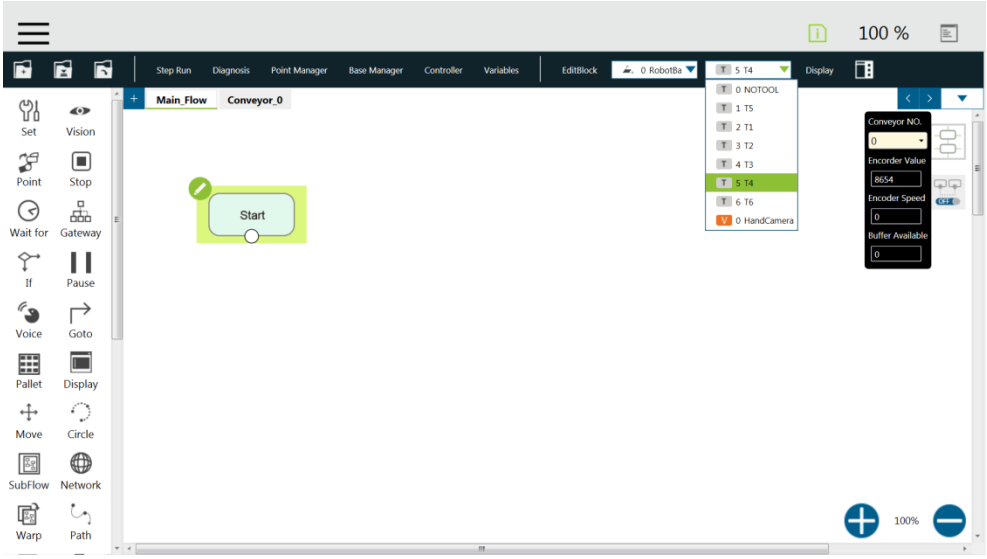
Step12 Click  to store visual task, and input the visual task's name.



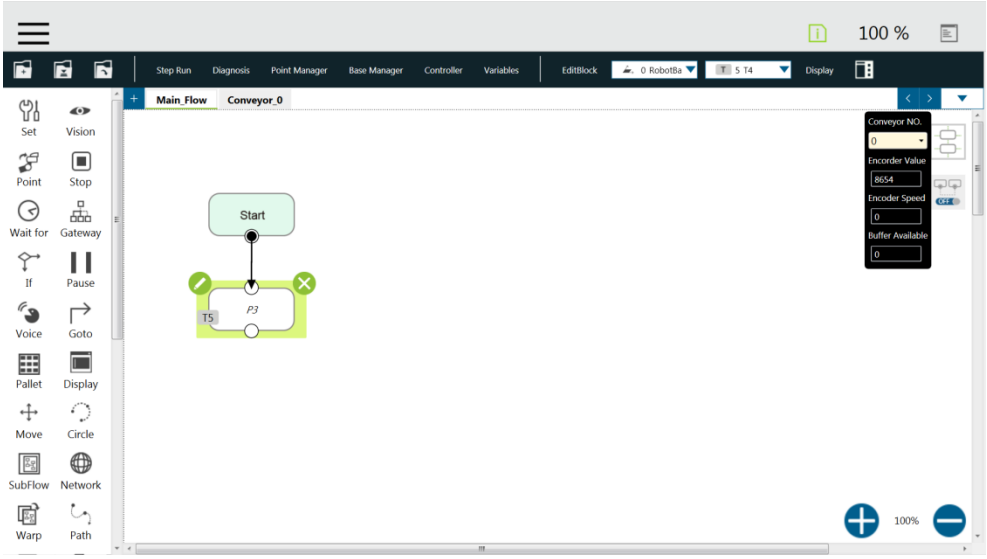
Step13 After returning to Flow, make sure the just edited visual field task exists. Click OK to complete setting.



Step14 Switch to the main thread to select the tool you need.

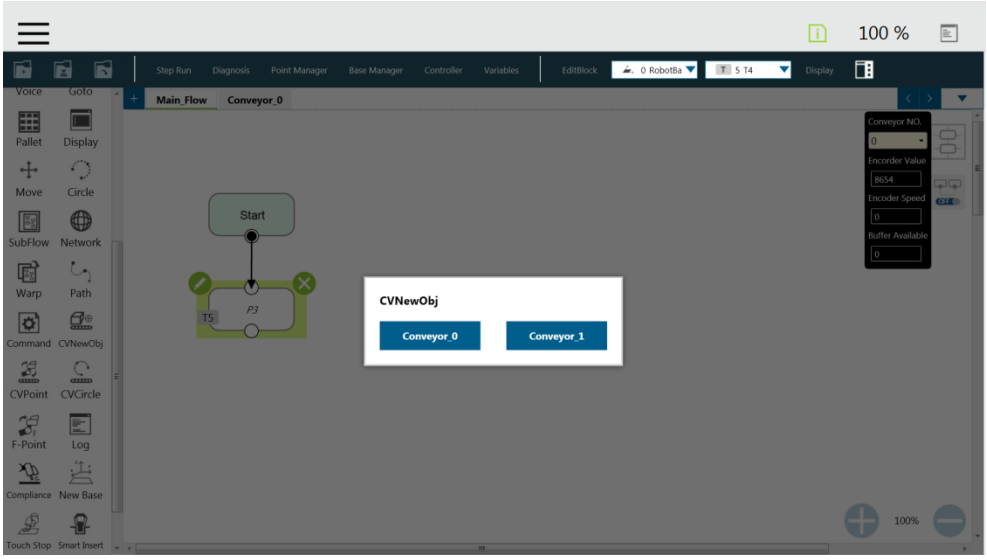


Step15 Pull out Point Node  and set as the robot's initial work point. (T5 is the selected tool)

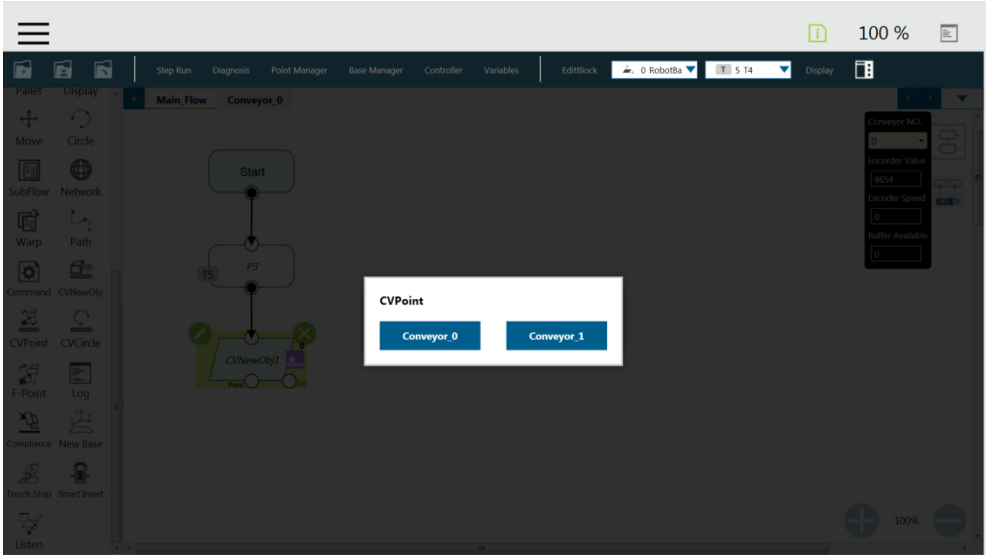


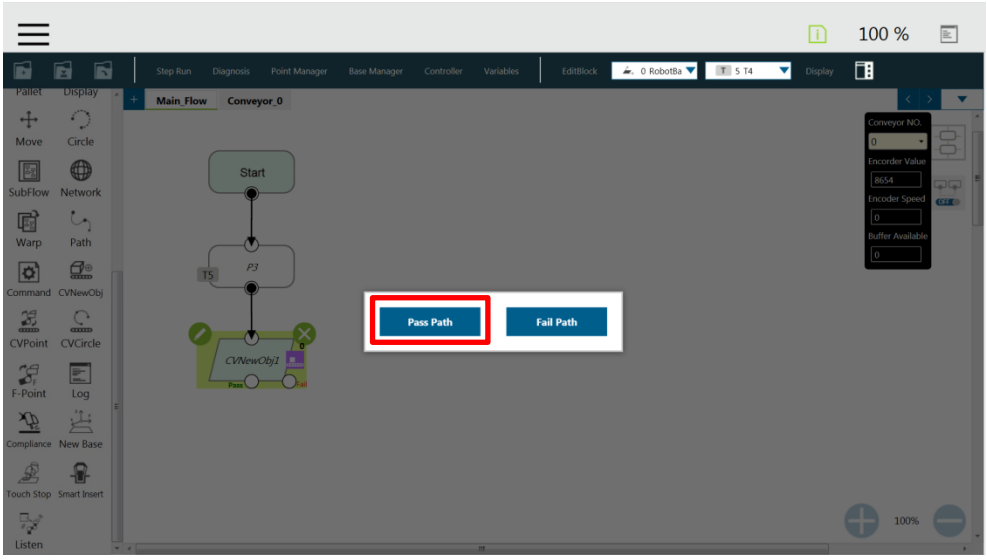
Step16 After pulling out CVNewObj 

, choose the conveyor number.



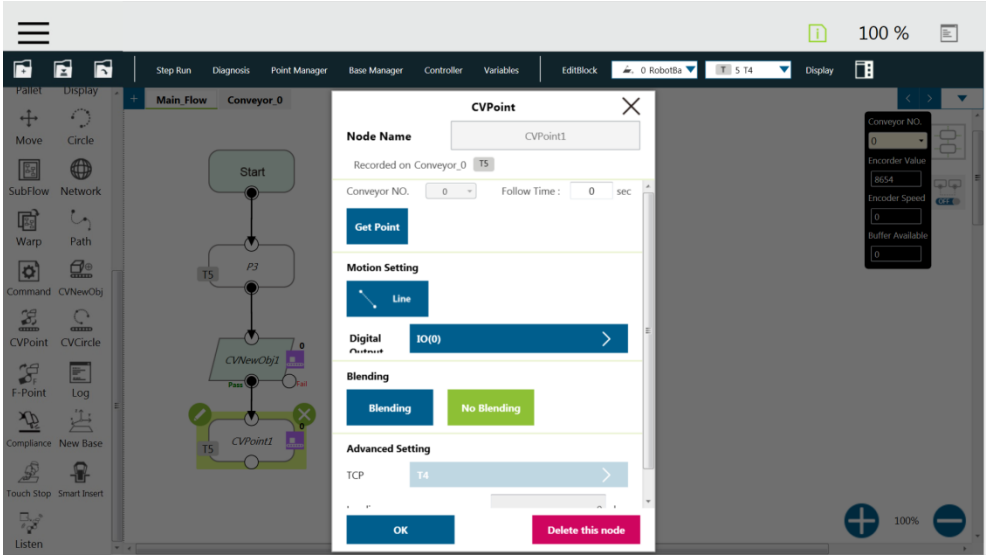
Step17	After pulling out the CVPoint  , choose the conveyor number,then choose [Pass Path].





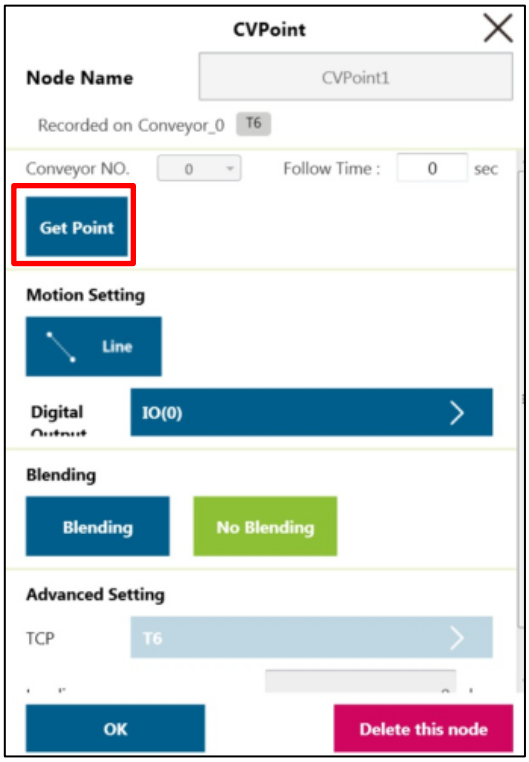
Step18

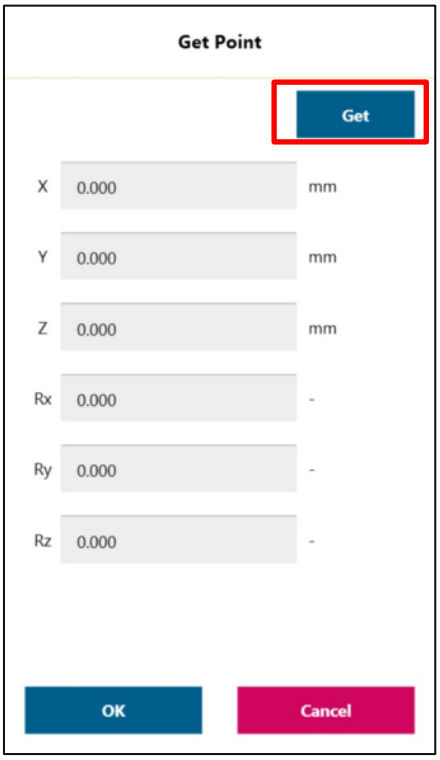
Click Enter the CVPoint Node setting screen. Use the conveyor to move the object to the robot's working area.



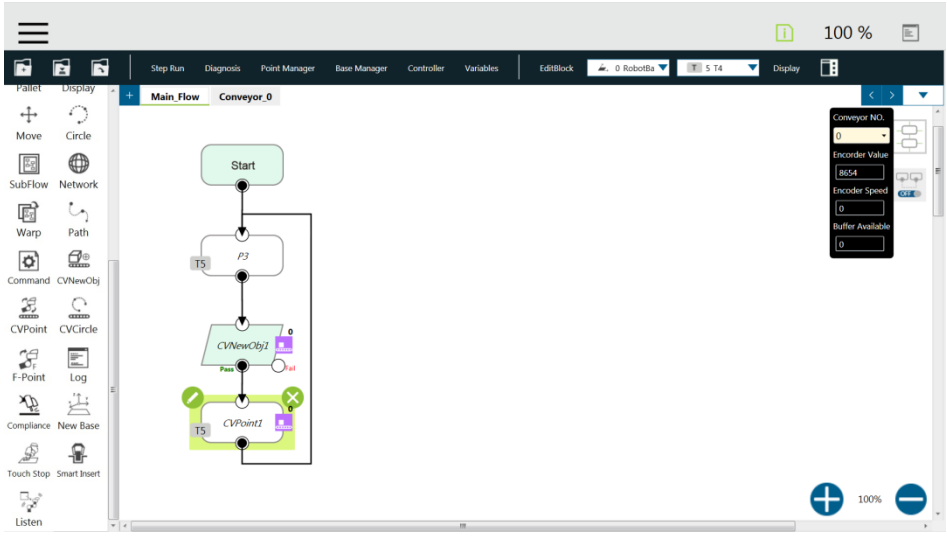
Step19

Move robot to the top of the object. Click GetPoint, then click Get to set positioning.Finally, click OK to complete CVPoint position setting.





Step20	Pull a line back to the P1 starting point to form a loop to complete a simple object tracking procedure.

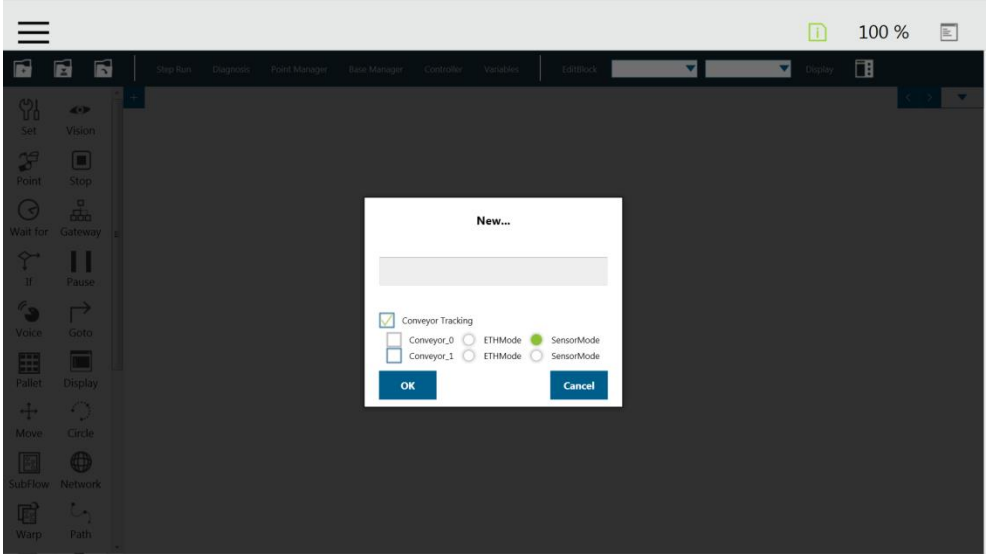


Remark:

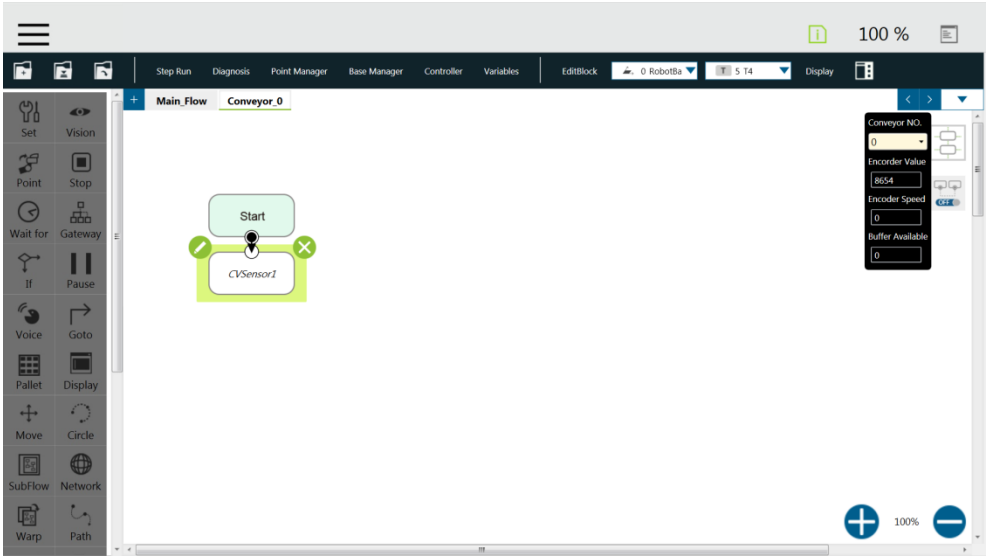
Advanced grab object setting can match with CVPoint end effector I/O status and point position setting to complete the grab and placement procedures.

5.2 SensorMode operation introduction

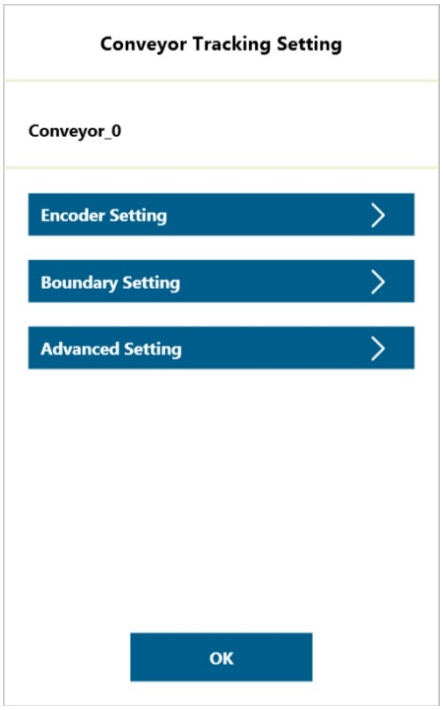
Step1	Select Conveyor Tracking. Choose SensorMode. Start editing the project of Conveyor Tracking's SensorMode.



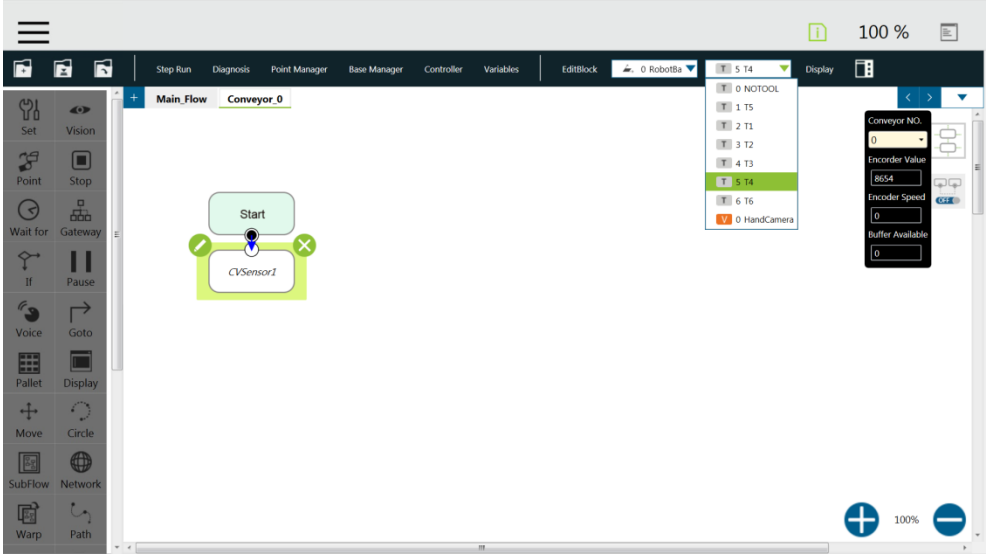
Step2	Two threads will appear. One is the main thread for editing the robot movement procedure (called Project Name) and the other is purely a sub-thread for adjusting Conveyor Tracking settings (this thread cannot add any nodes and is only for setup purposes). The sub-thread must be edited before the main thread can be edited.



Step3	Click the sub-thread's Start Node to proceed with Conveyor Tracking Setting. For related function information, please reference Chapter 4 Software function introduction.

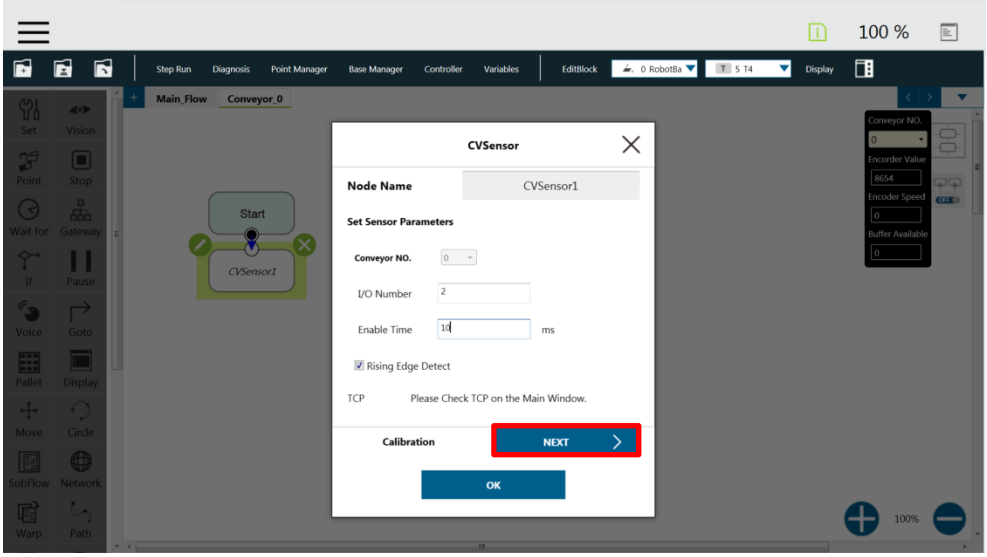


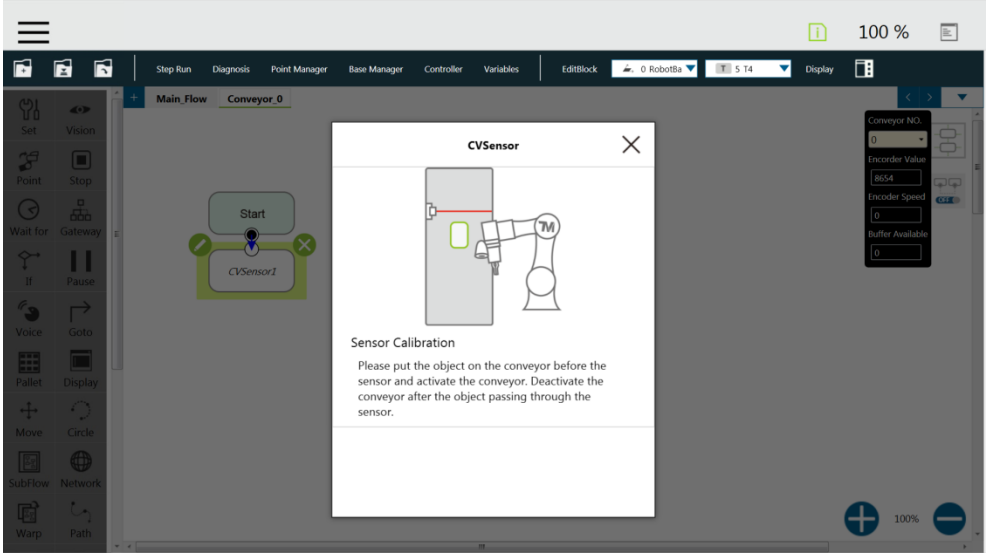
Step4	Select tool (recommend using the TM Calibration Set for more accurate positioning).



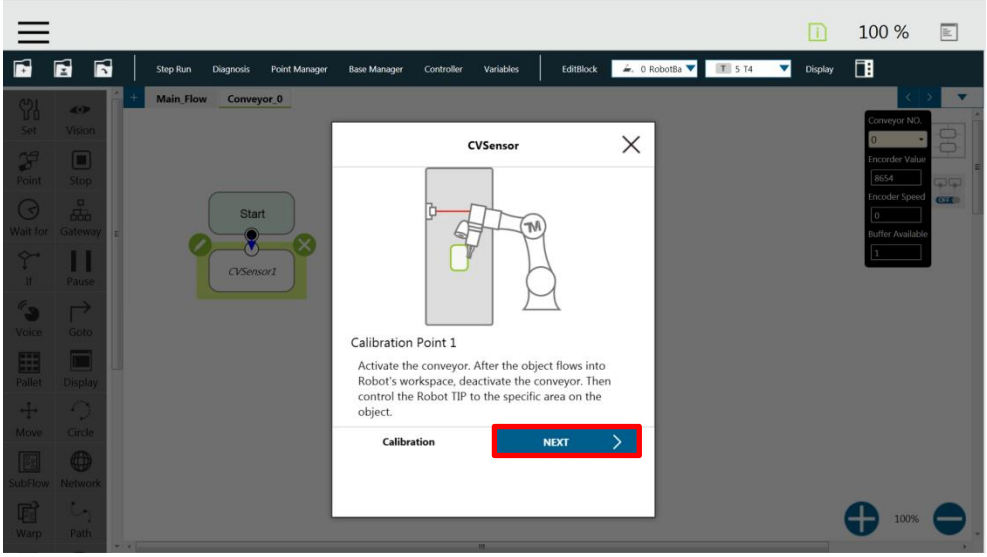
Step5

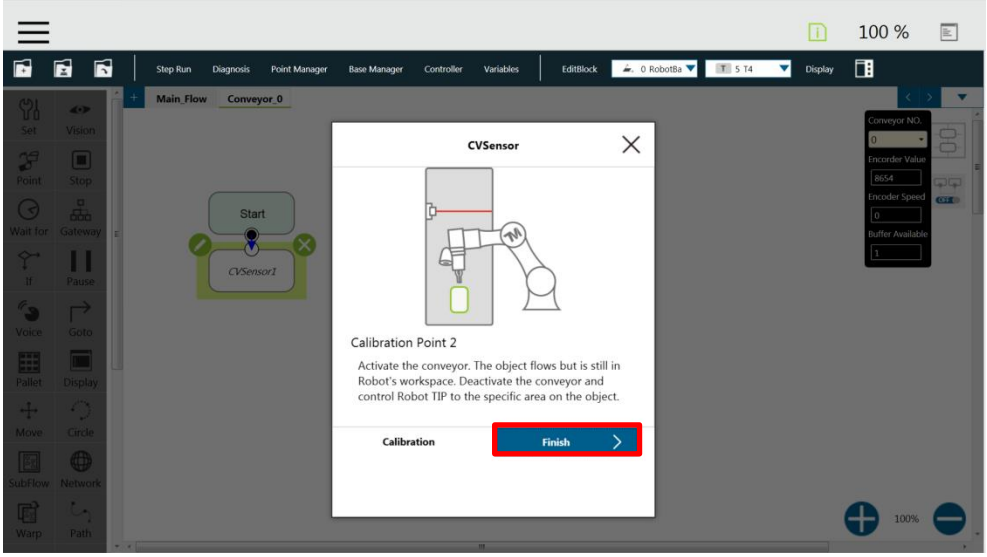
Click CVSensor's . Set IO Number (according to the sensor's IO position) according to the sensor trigger signal. If the trigger signal is high, please select high detect.After clicking NEXT, use conveyor to pass the object over the sensor. Then move the object to the robot's work range before stopping.



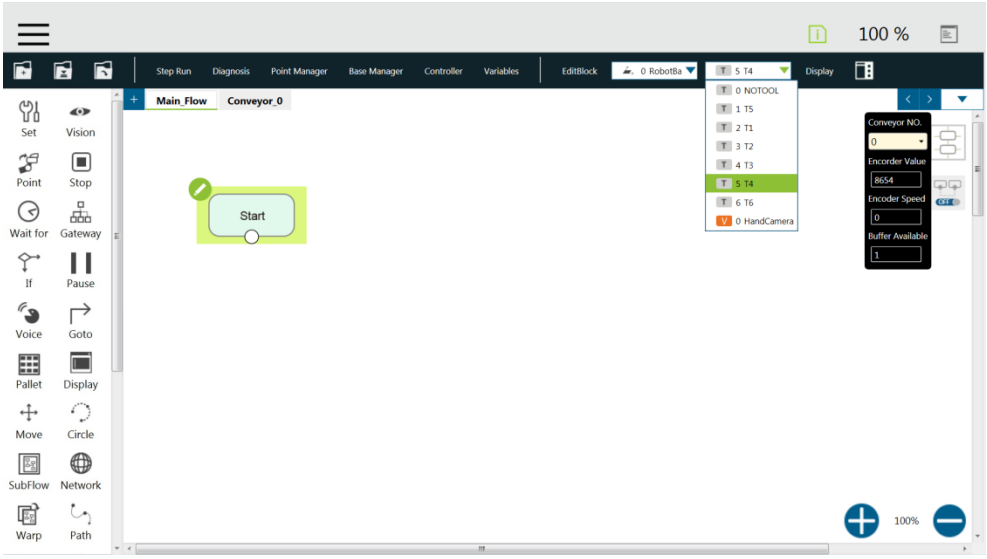


Step6	After stopping, move the robot so it contacts the object to set Calibration Point 1. Click NEXT, then activate conveyor so it moves a distance. Stop within the robot's working area. Then contact the same point of object to set Calibration Point 2. Click" Finish" to complete this setting.

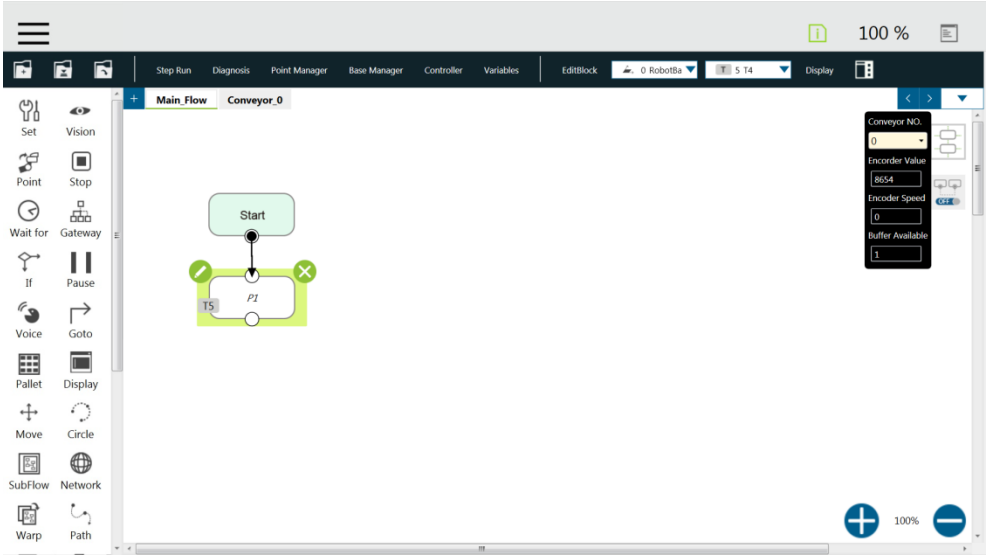




Step7	Switching back to main thread to change back to the tool you need.



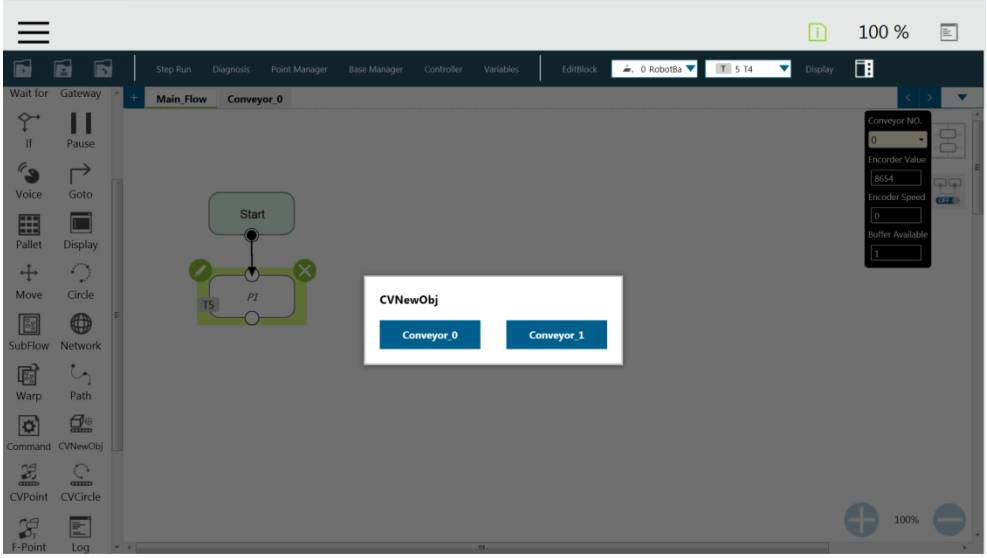
Step8	Pull out Point Node  and set as the robot's initial work point. (T5 is the selected tool)



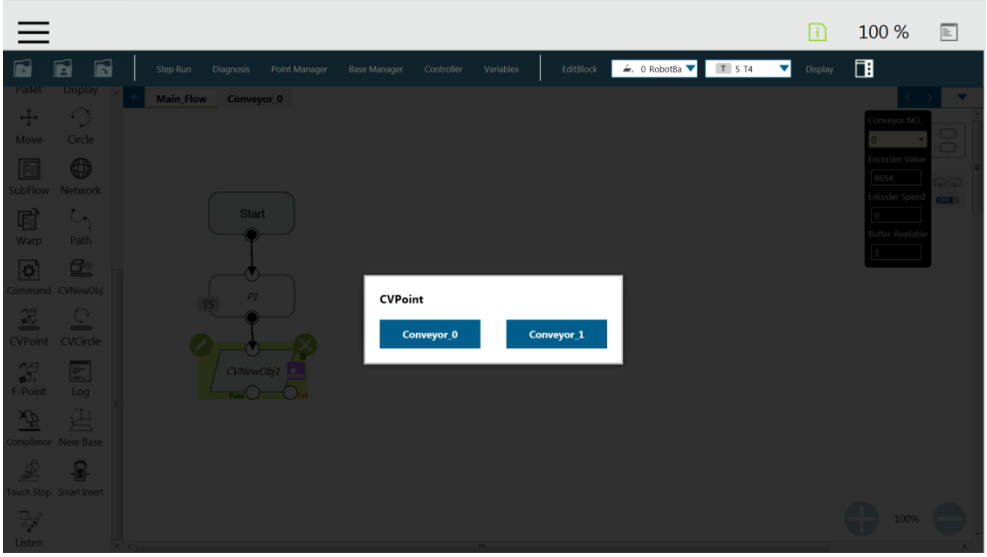
Step9

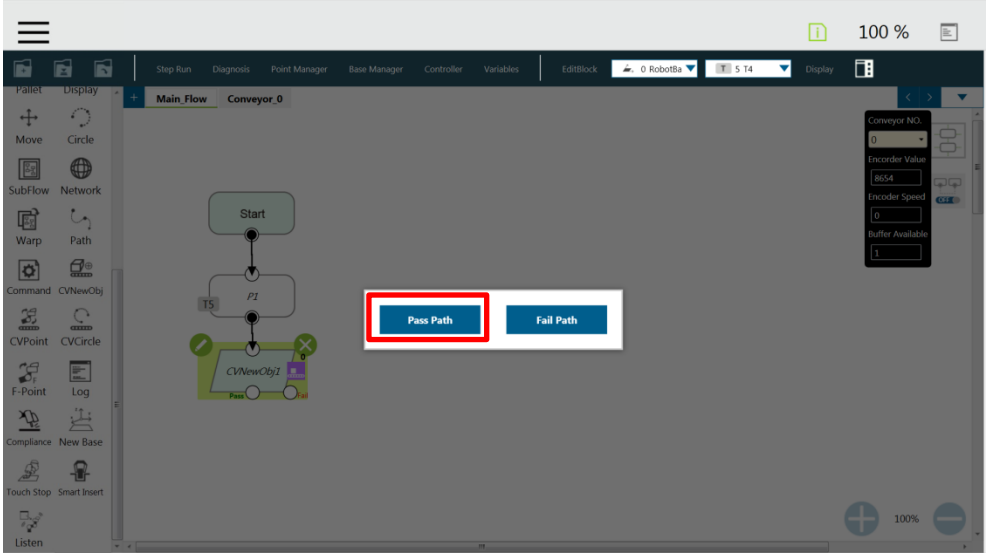
After pulling out CVNewObj 

, choose the conveyor number.



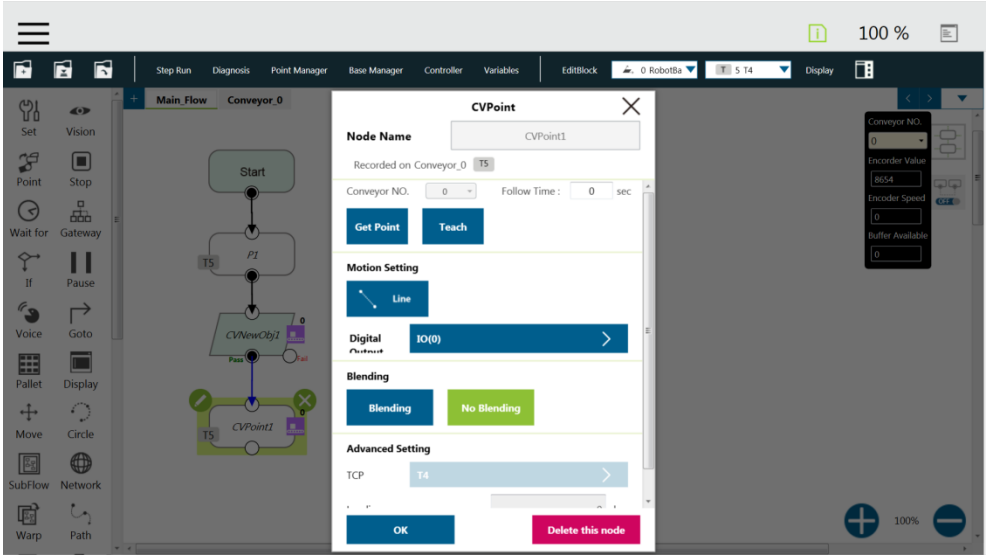
Step10	After pulling out CVPoint  ,choose the conveyor number, then select [Pass Path].

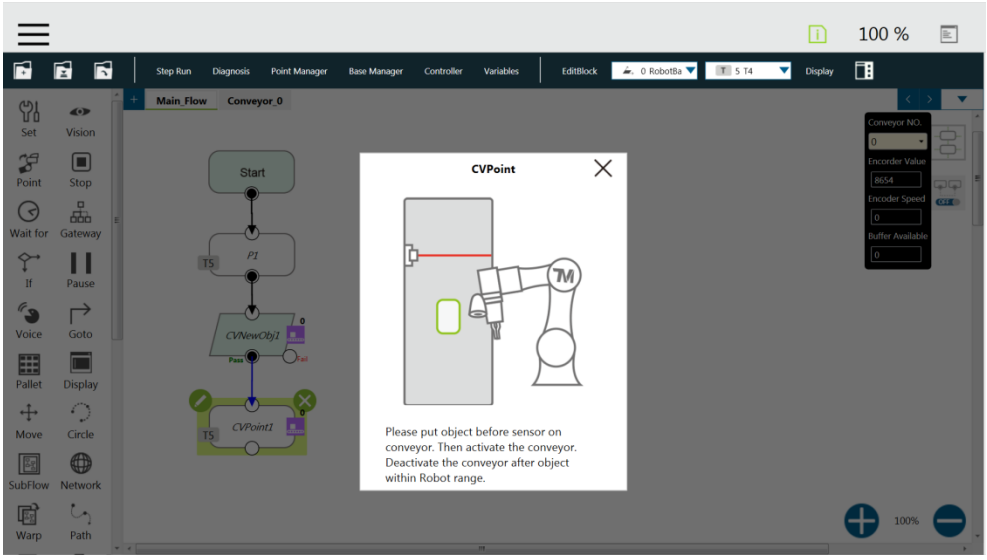




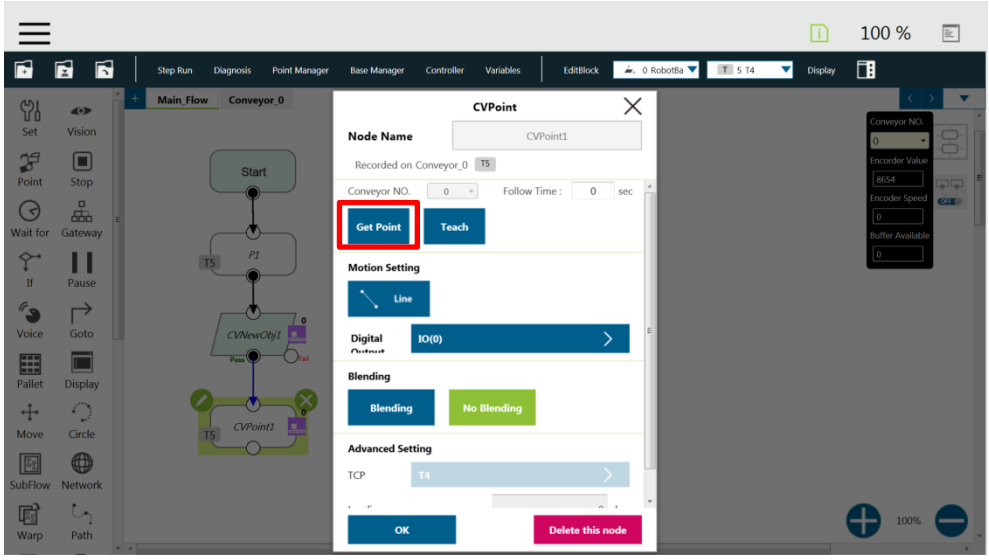
Step11

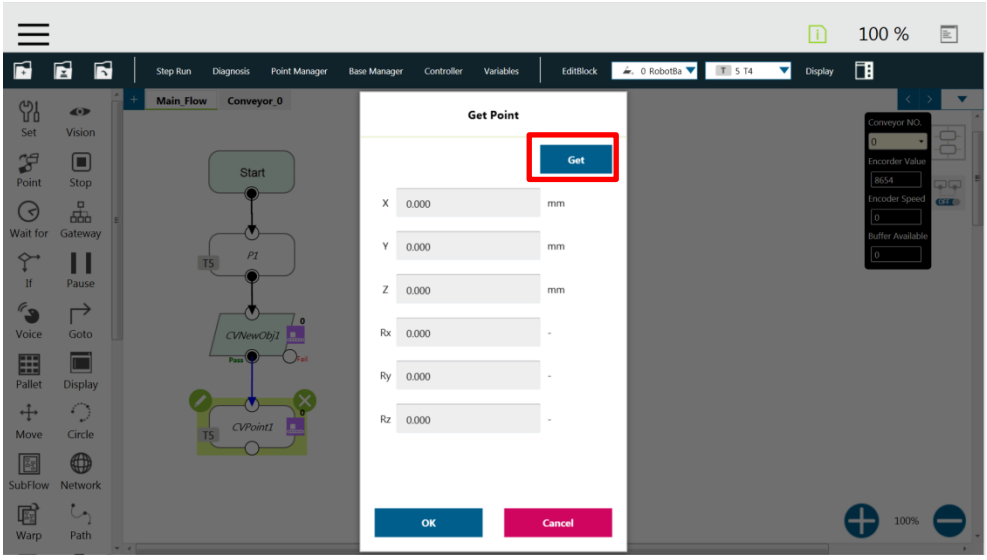
Click CVPoint's , then click Teach. After the icon appears,use the conveyor to pass the object over the sensor.When the sensor



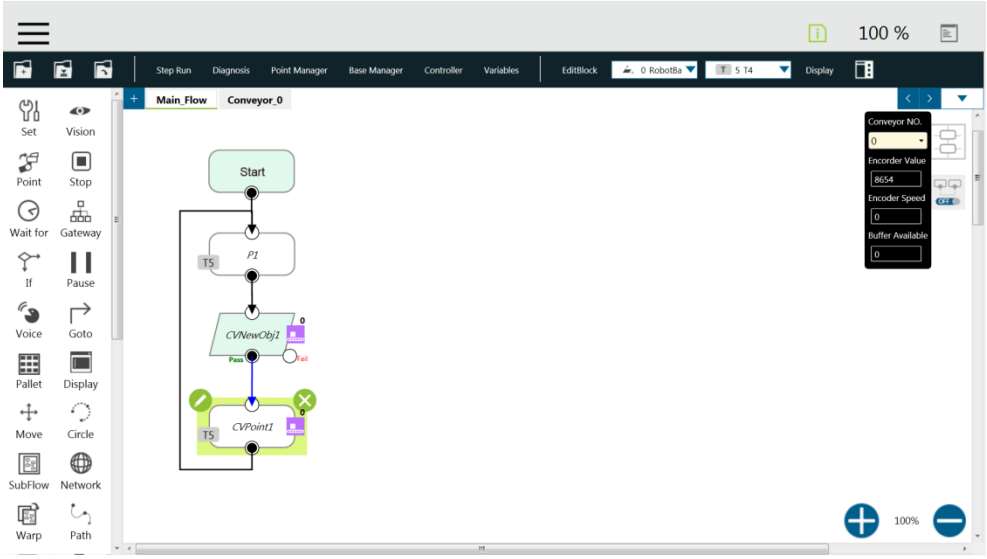


Step12	After the object passes the sensor, use the conveyor to move the object to the robot's working area. Click GetPoint, then click Get.





Step13	Pull a line back to the P1 starting point to form a loop to complete a simple object tracking procedure.



Remark:

Advanced grab object setting can match with CVPoint end effector I/O status and point position setting to complete the grab and placement procedures.

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