Lesson 13 Great Challenge of Intelligent Manufacturing

Scene lead-in

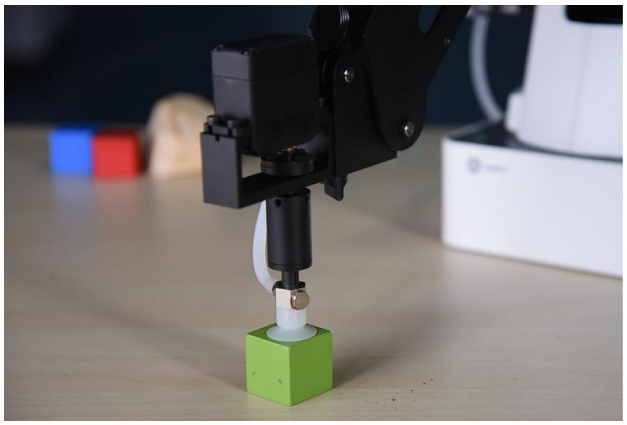
Construction of smart plants in the era of Industry 4.0

For the promotion of smart plant construction, smart production and logistics are crucial, particularly for intermittent manufacturing enterprises. During the planning of smart plants, unnecessary handling of materials shall be avoided as much as possible to improve the efficiency of handling. Many outstanding manufacturing enterprises have established automated production lines in the assembly workshop, where robotic arms can perform loading, unloading, transport, sorting and stacking of material via motion planning.

The intermittent manufacturing enterprises may apply the industrial robots, trussed robotic arms with rails, AGV, RGV or conveyor belts, etc. to convey the materials between two mechanical procedures. The production buffer zone shall be set in the workshop according to the difference of capacity between the previous and next procedures.

Differences and relationships among motion planning, route planning and track planning

Motion planning



Motion planning is composed of route planning and track planning (time). The word "route" refers to the sequence point or curve connecting the start position and final position, and the strategies constituting the route are called route planning.

The route is a certain sequence of the robot's posture without consideration of the factors that the robot's posture parameters vary along with the time change. For the route planning, it is required to find a series of route points by which the robot will pass, where the route points are locations or joint angles in the space. By contrast, track planning is to indicate time information for the route.

Motion planning serves to insert an intermediate point sequence between the given route terminals for control, so as to realize the stable motion along the route between the given starting point and terminal point. Motion control mainly solves the problem of controlling the target system to accurately follow up the command track.

Route planning aims to maximize the distance between the route and barriers and minimize the length of the route at the same time. Track planning aims at minimizing the operating time of robot during spatial displacement of robot joint, or the energy consumption. The time serial information is added to the track planning based on the route planning. Speed and acceleration shall be planned when the robot performs a task, so as to meet such requirements as smoothness and speed controllability.

Differences and relationships among motion planning, route planning and track planning

Creative Design

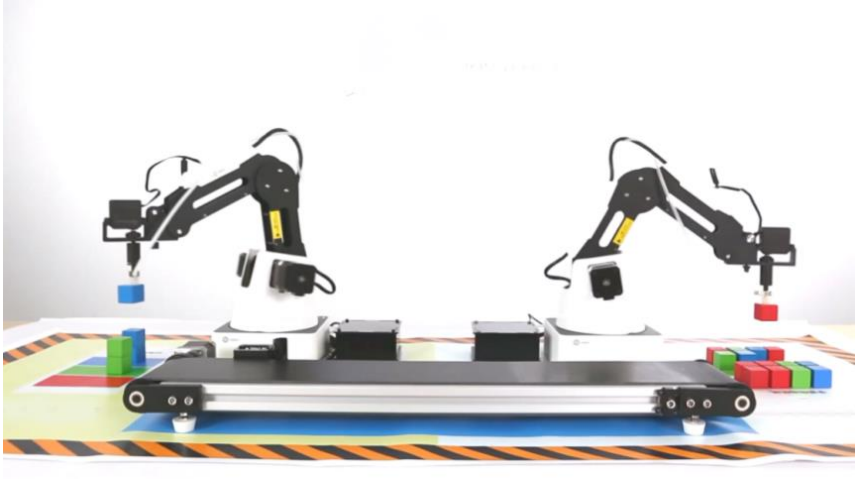
Project practice: Great Challenge of Intelligent Manufacturing

Requirements of project: Use two robotic arms and one mini conveyor belt to complete the handling, identification, classification and stacking of articles via the intelligent program Blockly control.

Proportion of score of project: 1. Accuracy of handling area (70%)

2. Time to complete task (10%)

3. Innovation and simplicity of program (20%)



Step I: Install the kits of Industry 4.0

Step II: Collect and record the Cartesian coordinates of articles at the breakpoint and end-point using DOBOTStudio

1. Start DOBOTStudio and select the teaching-playback

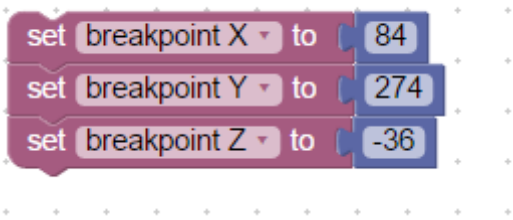
2. Hold the robotic arms and mark the breakpoint and end-point.

Step III: Programming

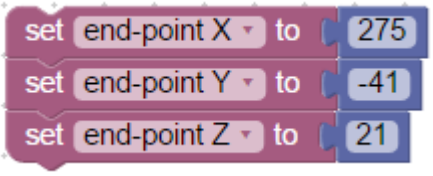
I. Smart manufacturing challenge - example of handling program

1. Set the speed and acceleration

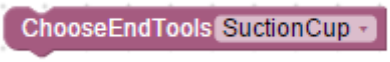
2. Set the three-dimensional coordinates of the breakpoint



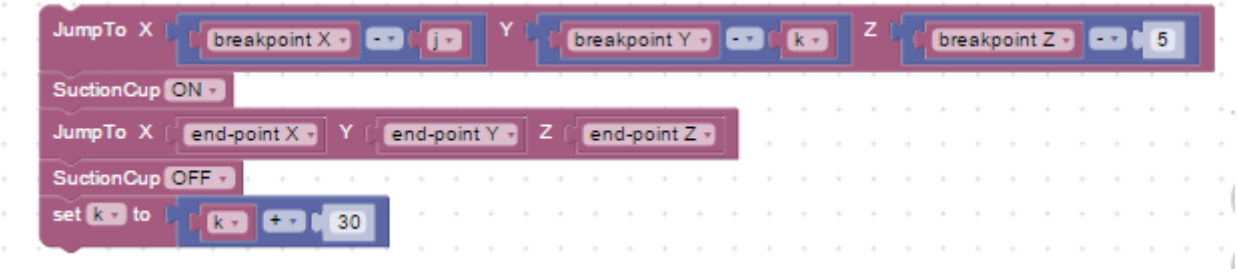
3. Set the three-dimensional coordinates of the end-point



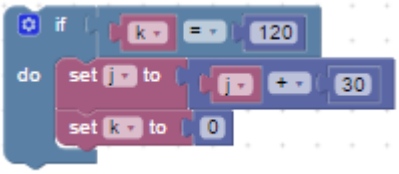
4. Select the tail end of robotic arm as the adhesive disc



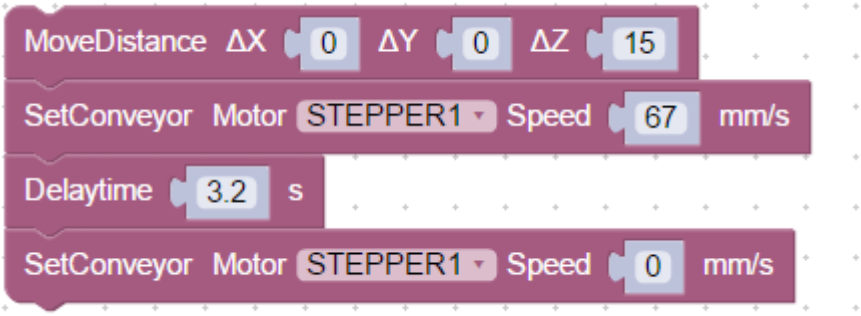
5. Control the robotic arms to grab articles and carry them from the breakpoint to the end-point



6. Set the row and column for repeated execution. Four articles will be included in each row and each article will be placed at a spacing of 30 mm. When grabbing the articles in one row, the robotic arm will move to the next row to grab continuously.



7. Set the speed of conveyor belt as 67 mm/s and the conveyor belt will stop for 3.2 s while the belt runs to the tail end.

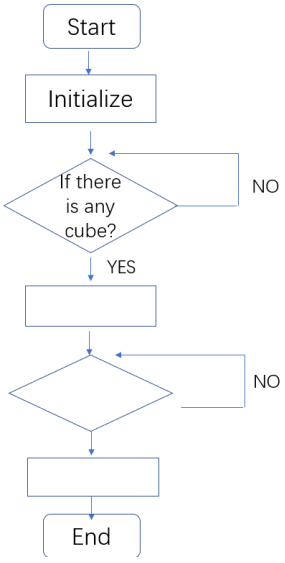


8. Set the times of repeated execution according to the quantity of articles. (Take 12 times as an example)

Program the flow chart of this program according to the program of the handling example and conduct self-debugging to achieve the handling function required in the smart manufacturing challenge.

II. Great Challenge of Intelligent Manufacturing - example of sorting

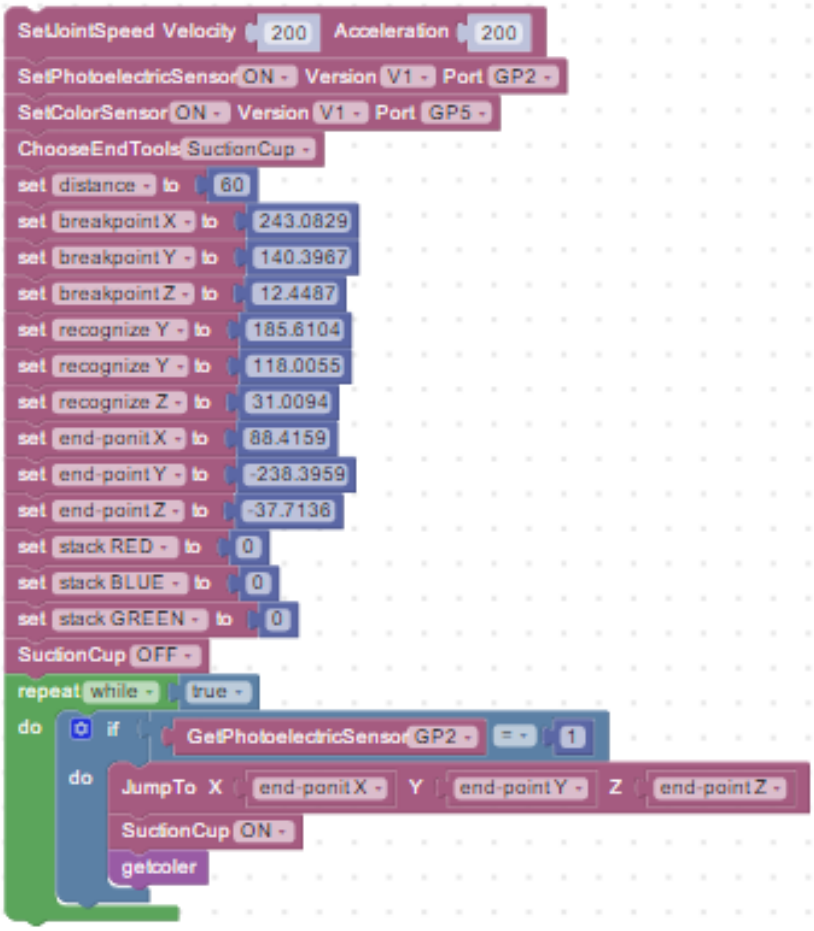
1. Sort the flow chart of sorting and fill in the flow chart

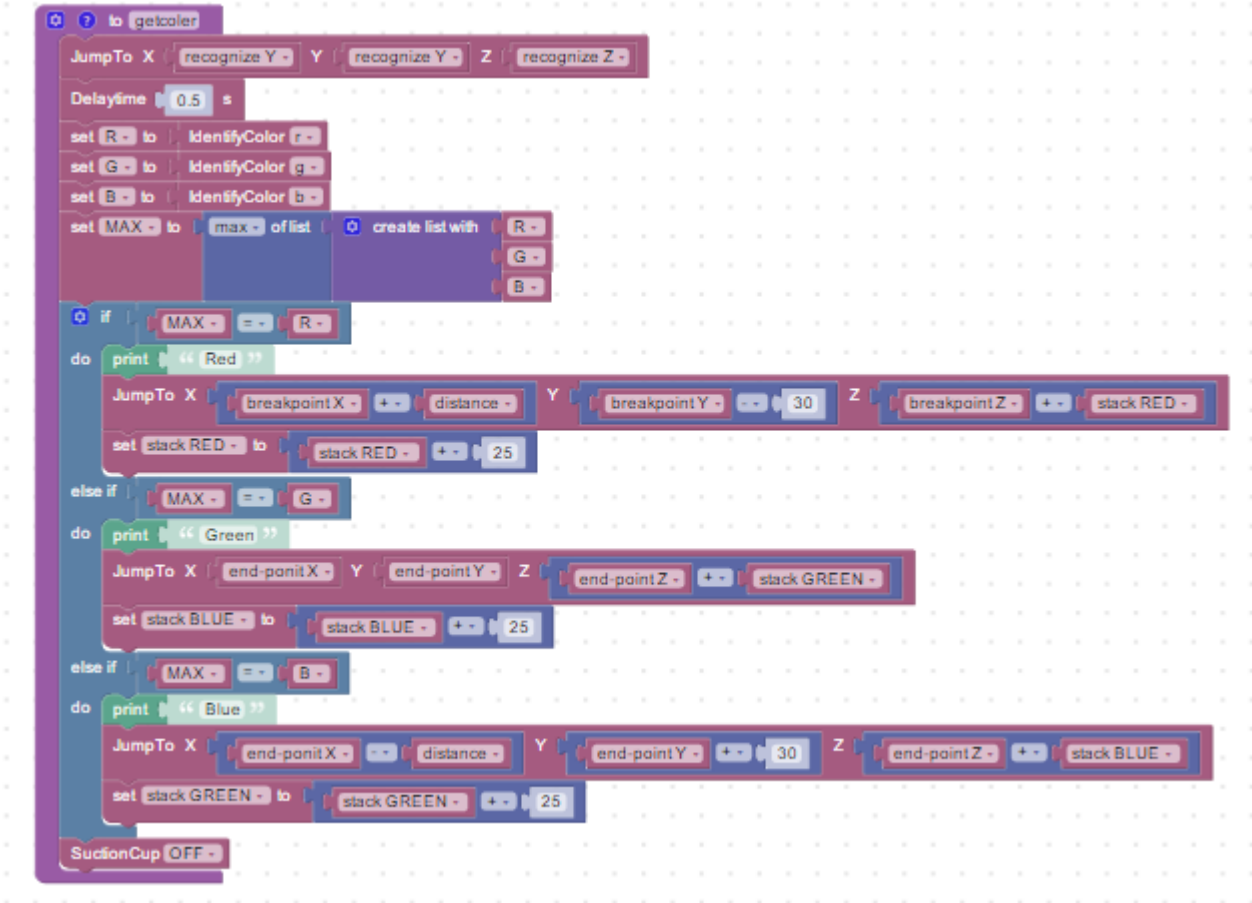


2. Try to perform programming for the sorting part of the great challenge of intelligent manufacturing according to the flow chart

Problem Solving

Why does the robotic arm not grab at the starting point of the conveyor belt?
Why is blue always confused with green during the color placement?





Share and Show

What are the difficulties in flow sorting and programming in the sorting part of the great challenge of intelligent manufacturing? How do you solve it?

Comprehensive evaluation

Evaluation method	Evaluation link	Evaluation content	Evaluation criteria		
			3 Excellent	2 Good	1 General
Self-evaluation	Scenario Introduction	• Understand the construction operations of smart plants in the era of Industry 4.0			
	Requirement of the Class	• Grasp the relationship between motion planning and the assembly line • Know the differences between motion planning, track planning and route planning			
	Practice in Class	• Carefully and actively set up and debug the handling program • Actively undertake programming tasks for the team			

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Technologie Services
Zi du Gavé
42330 Saint-Galmier
Fax : 04 77 94 55 14
Mail : contact@technologieservices.fr

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