2024

BRICS SKILLS COMPETITION

(BRICS FUTURE SKILLS & TECHNOLOGY CHALLENGE)

Industrial Robot Digital Twin Technology Application

BRICS-FS-40

Test Project_Online

(International Final)

July, 2024

Task 1 Virtual construction of integrated system

Use PQFactory software to open the CHL-KH01.robx file of the competition file provided, and open the display interface as shown in Figure 1-1. According to the following installation steps, put each working unit placed on the shelf and reasonably assemble it to the surface of the workbench.

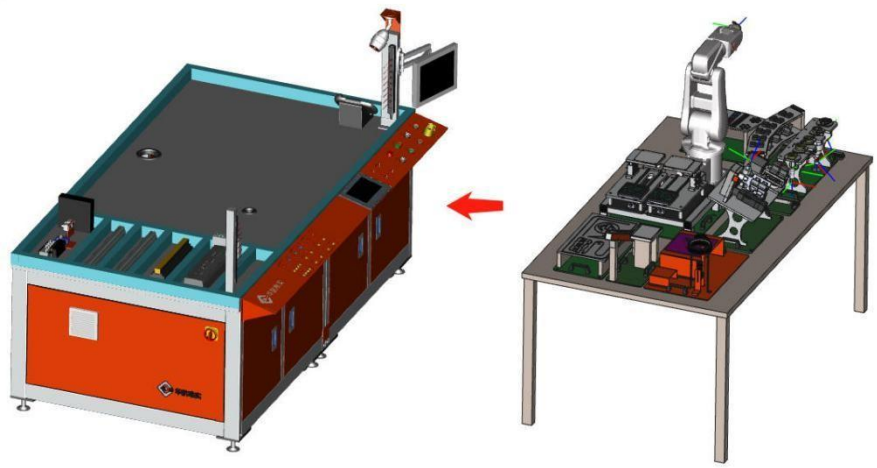

Figure 1-1 The PQFactory file

Assembly considerations:

The assembly and base surface of each working unit should be fitted to the table of the workbench. The dimensions are the spacing between the sides of the work unit and the inside sides of the workbench frame. For missing the dimensions on the picture, refer to the installation dimensions.

(1) Install the "glue coating unit" (installation size: 197 mm 531 mm);

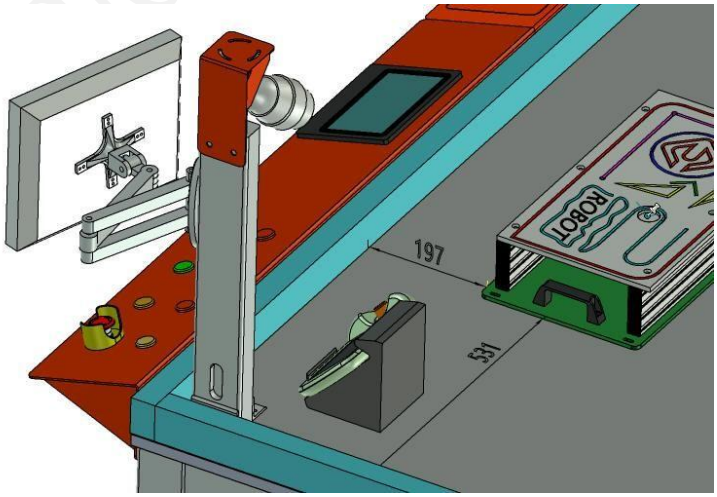

Figure 1-2 Size drawing of the glue-coating unit

(2) Install the "palletizing unit" (installation size: 370 mm 156 mm);

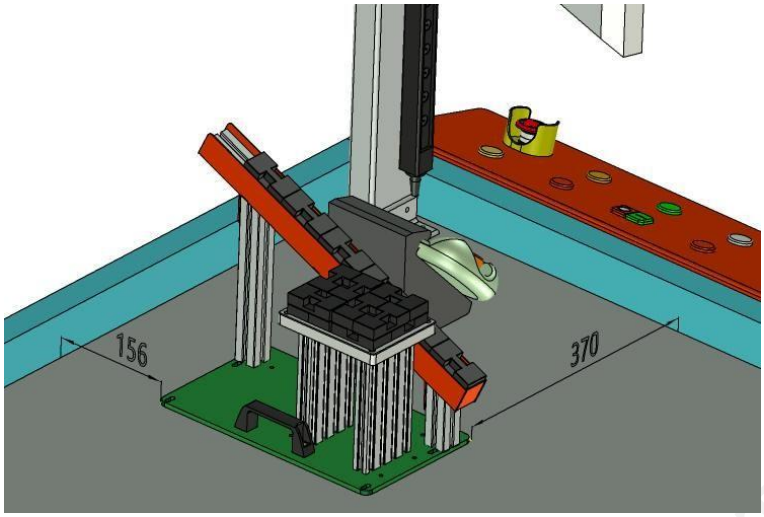

Figure 1-3 Size diagram of the palletizing unit

(3) Install the "visual unit" (installation size: 80 mm 531 mm);

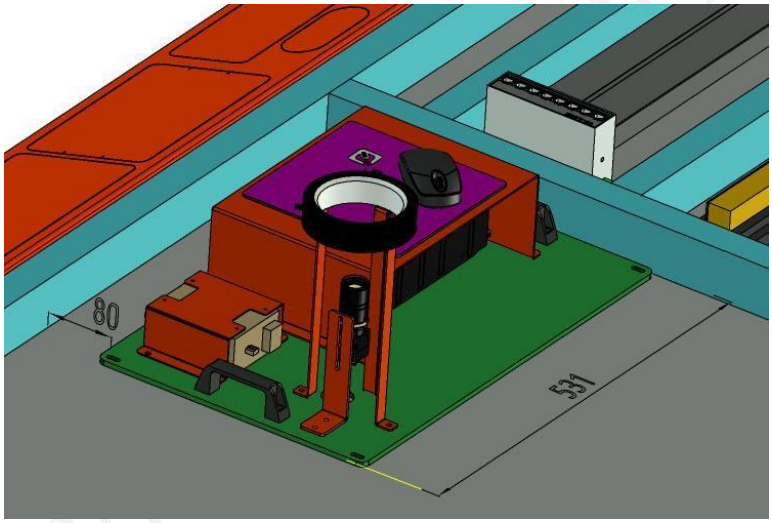

Figure 1-4 Plot for visual unit dimensions

(4) Install "special-shaped chip library" (installation size: 180mm 461mm);

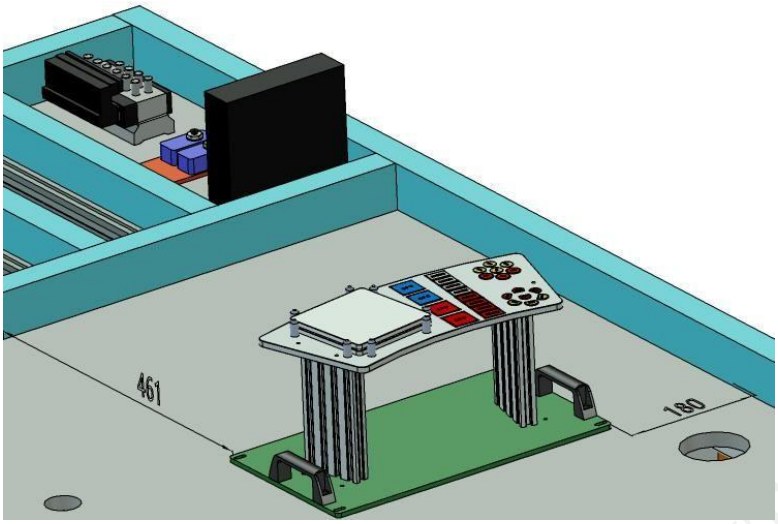

Figure 1-5 Size diagram of alien chip library

(5) Install the "assembly unit" (installation size: 115 mm 421 mm);

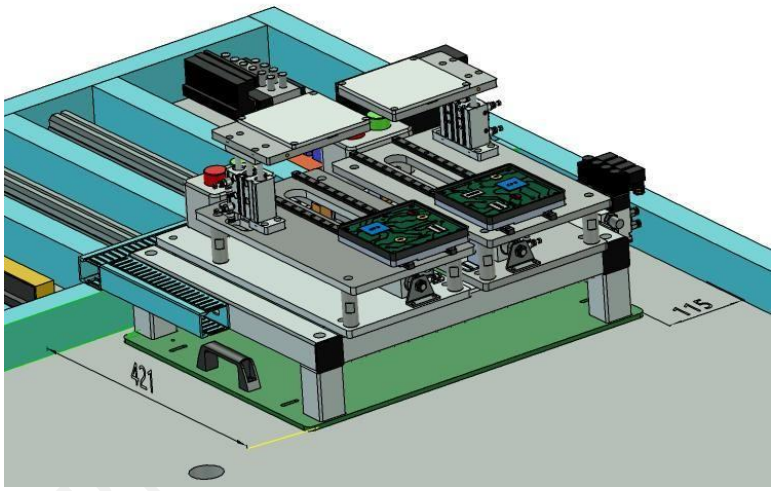

Figure 1-6 Plot for assembly cell dimensions

(6) Install "multi-process unit" (installation size: 75 mm 121 mm);

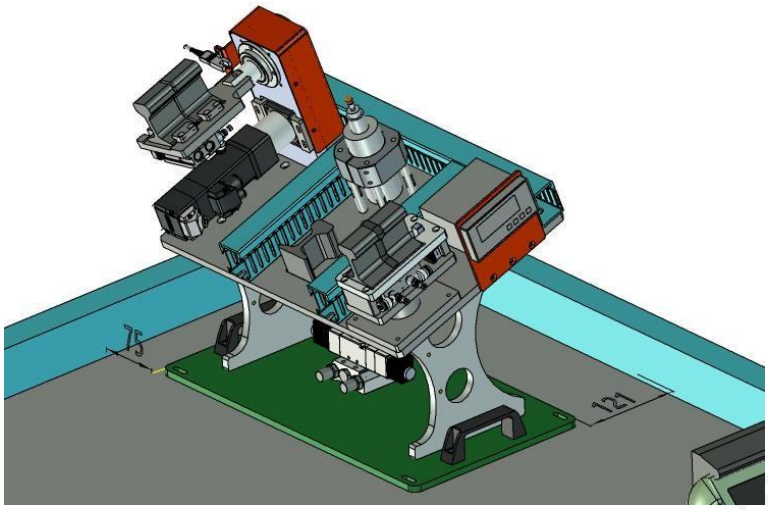

Figure 1-7 Size diagram of multiple process units

(7) Install the "warehouse unit" (installation size: 50 mm 380 mm);

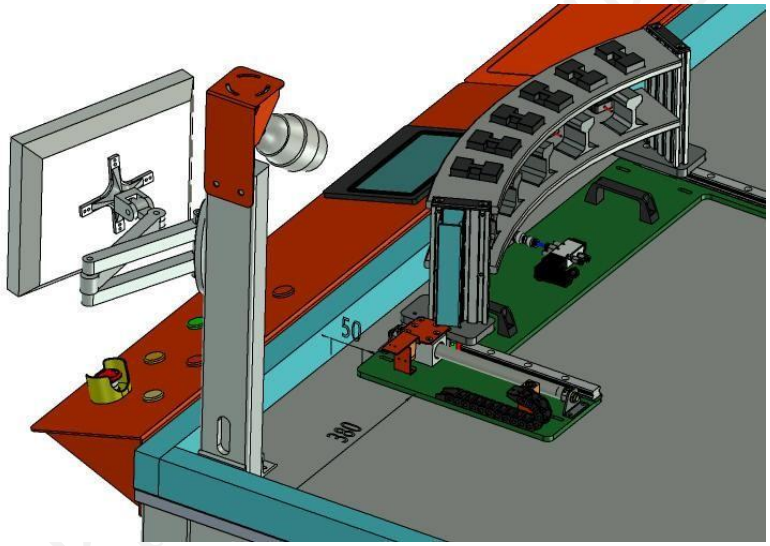

Figure 1-8 Size diagram of the warehouse unit

(8) Install the "quick change tool unit" (installation size: 48mm 441mm);

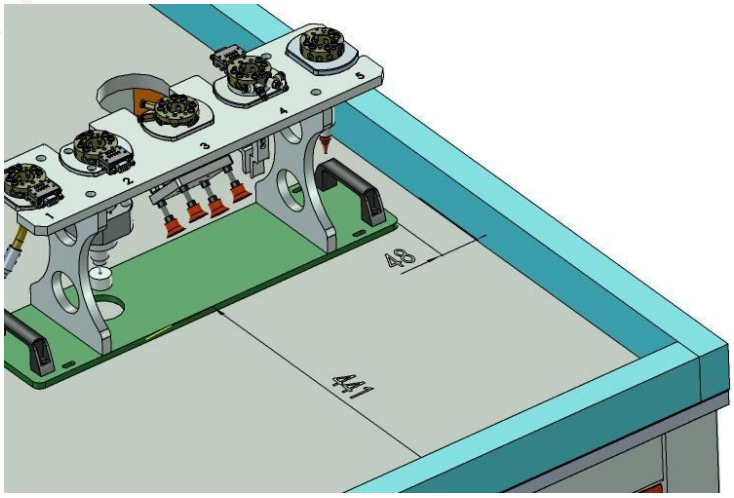

Figure 1-9 Size diagram of the quick-change tool unit

(9) Install the "robot unit" (installation size: 320 mm 641 mm);

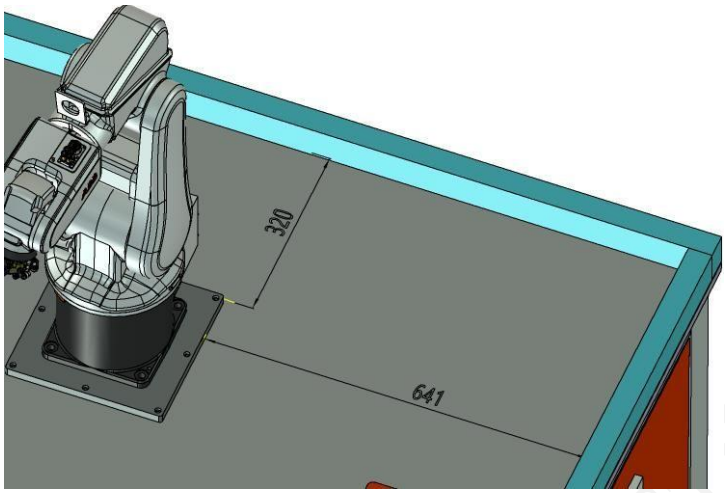

Figure 1-10 Size diagram of the robot unit

(10) Adjust the position of assembly unit A04 and A06, place A04 on station 2 and A06 on station 1;

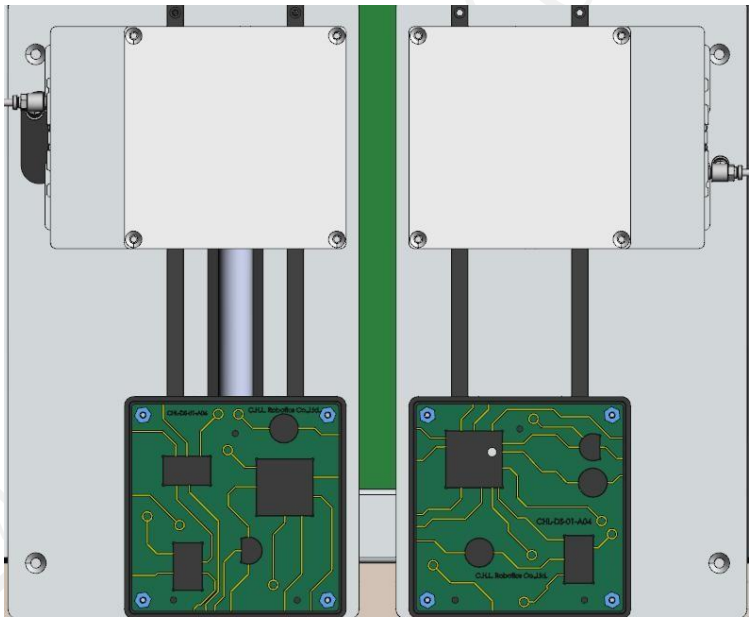

Figure 1-11 Display diagram of the circuit board after adjustment

(11) Set the current state as the initial state of the workstation and add "snapshot" to the software.

Task 2 Definition of Mechanical / Electrical Behavior

(I) State machine definition

1. Under the model "scenario", find the "lifting cylinder 1" and "lifting cylinder 2" assembly, and defined as state machine, named "lifting cylinder 1 state machine", set the state machine as "translation", minimum range "," 0mm ", maximum" 10mm ", Z coordinate negative direction of the robot base system; set two states, state 1 is rising state, movement time 0s, joint value 0mm, state 2 is a drop state, movement time 1s, and joint value 10mm.

2. Under the model "scenario", find "push cylinder 1" and "push cylinder 2" assembly, rename assembly components, and define as state machine, named "push cylinder 1 state machine" and "push cylinder 2 state machine", set the state machine motion mode as "translation", the minimum motion range "-200mm", maximum "0mm", the direction is the Y coordinates of the robot base system; set two states, state 1, motion time 0s, joint value 0mm, state 2 is retraction state, motion time 1s, joint value-200mm.

(2) Sensor definition

1. Under the model "parts", the station 1 and station 2 sensors of the stereo warehouse are defined to have the sensor detection function, which can detect the guide block on station 1 and station 2 respectively. Variables are named "M130" and "M131".

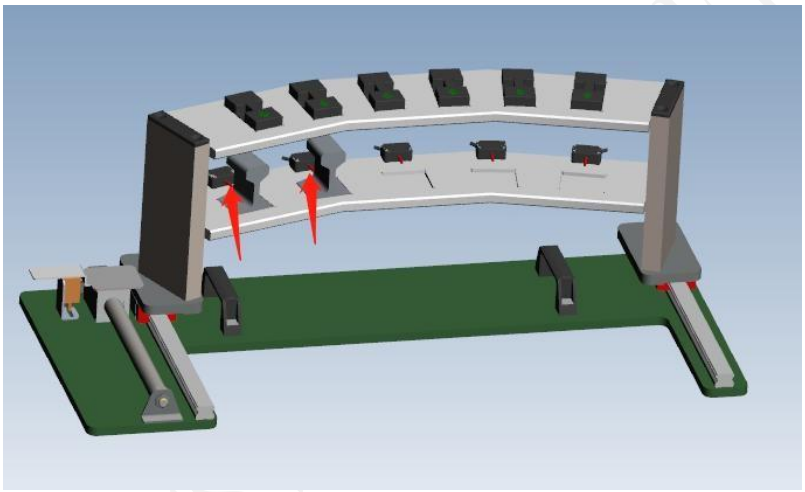

Figure 2-1 Schematic diagram of the stereo warehouse sensor

(3) Part definition

Set the color status of the red and green indicators and LED detection lights in the model, and the defined variable address and color change requirements are as follows in Table 2-2.

Table 2-2 Requirements for color definition

order number	Internal variables	function annotation	Color requirements
1	M110	Station 1 red indicator light	Light on the light display turn off the light display
2	M111	Station 1 green indicator light	Light on the light display

			turn off the light display
3	M112	Station 2 red indicator light	Light on the light display turn off the light display
4	M113	Station 2 green indicator light	Light on the light display turn off the light display
5	M114	Station 1 detection lamp	Light on the light display turn off the light display
6	M115	Station 2 detection lamp	Light on the light display turn off the light display

Task 3 IO signal configuration and association

(I) Definition of the state machine variable

Variables are defined for the telescopic cylinder and the lifting cylinder in the model. The defined variable addresses are shown in Table 3-1 below.

Table 3-1 Variable address

order number	address	function annotation	order number	address	function annotation
1	M100	Lift cylinder 1	1	M120	Lift cylinder 1 rise position
2	M101	Push cylinder 1	2	M121	Lift cylinder 1 down position
3	M102	Lift cylinder 2	3	M122	Push cylinder 1 out
4	M103	Push cylinder 2	4	M123	Push cylinder 1 reretracted
5	M104	Three-dimensional warehouse sliding mechanism	5	M124	Lift cylinder 2 rise position
-	-	-	6	M125	Lift cylinder 2 down position
-	-	-	7	M126	Push cylinder 2 out

-	-	-	8	M127	Push the cylinder 2 to retract
-	-	-	9	M140	The sliding mechanism is in place
-	-	-	10	M141	The sliding mechanism of the stereo warehouse is retracted into place

(2) Address matching

In the address matching of PQFactory software, make signal configuration, configure the variables involved in Table 2-2 and Table 3-1 and the sensor variables on the "stereo warehouse" station 1 and 2, associate them to the variables of PLC, and the matching address is as shown in Table 3-2;

Table 3-2 Address Matching Table

order number	PQFactory Internal variables	The PLC corresponds to the address variable	function annotation
1	M100	M10.0	Lift cylinder 1
2	M101	M10.1	Push cylinder 1
3	M102	M10.2	Lift cylinder 2
4	M103	M10.3	Push cylinder 2
5	M104	M10.4	Three-dimensional warehouse sliding mechanism
6	M110	M11.0	Station 1 red indicator light
7	M111	M11.1	Station 1 green indicator light
8	M112	M11.2	Station 2 red indicator light
9	M113	M11.3	Station 2 green indicator light
10	M114	M11.4	Station 1 detection lamp
11	M115	M11.5	Station 2 detection lamp
12	M120	M12.0	Lift cylinder 1 rise position
13	M121	M12.1	Lift cylinder 1 down position
14	M122	M12.2	Push cylinder 1 out

15	M123	M12.3	Push cylinder 1 reretracted
16	M124	M12.4	Lift cylinder 2 rise position
17	M125	M12.5	Lift cylinder 2 down position
18	M126	M12.6	Push cylinder 2 out
19	M127	M12.7	Push the cylinder 2 to retract
20	M130	M13.0	Storage sensor 1
21	M131	M13.1	Storage sensor 2
22	M140	M14.0	The sliding mechanism is in place
23	M141	M14.1	The sliding mechanism of the stereo warehouse is retracted into place

1、 In KingIOServer, software, create a new project, add a protocol for communication with the PLC module, and create a new PLC address IO variable shown in Table 3-2;

Task 4 Virtual Programming and Commissioning of Industrial Robot

Complete the trajectory generation of industrial robots in PQFactory software, requiring the generated trajectory compilation without unreachable point, no singularity point, and no axis overlimit.

NO.1 Offline programming and debugging of the selecting and discharging tools

(1) Home point setting: the Home point attitude of industrial robot is 1 axis, 2 axis, 3 axis, 4 axis and 6 axis joint of the body is 0°, and 5 axis joint is 90°;

(2) Generate a track group for automatic installation of claw clip quick change tool, named "Get _ Grip", the starting point and final point are Home points;

(3) Generate a track group of automatic unloading clip claw fast change tool, named "Put _ Grip" start point and final point as Home point;

(4) Generate a track group of automatically installed sucker quick change tool, named "Get_Suction" start point and final point as Home point;

(5) Generate the track group of the automatic unloading sucker quick change tool, named the "Put_Suction" start point and the final point as the Home point.

NO.2 Offline programming and debugging of palletizing and unstacking

In PQFactory software, complete the action track of industrial robot palletizing, the specific requirements are as follows:

1. Industrial robots start to run from the safe point Home point;

2, industrial robot installation claw tools;

3. The industrial robot takes out 6 materials from the bottom of platform A (Figure 4-1) and puts them to platform B in the serial number order, and the stack type is shown in Figure 4-2; (Note: the material block must be generated by the "part generator" of the software)
4, industrial robot unloading claw tool;
5. Industrial robots return to the safety point Home point.

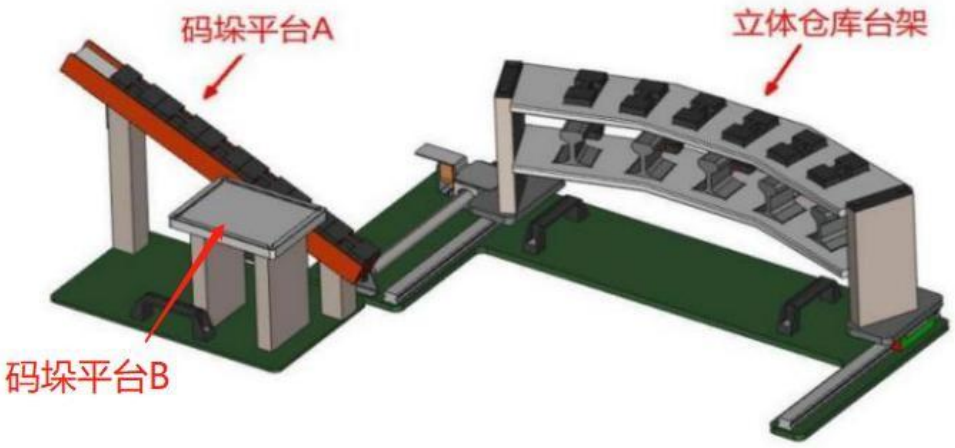

Fig. 4-1 Cackletizing platform

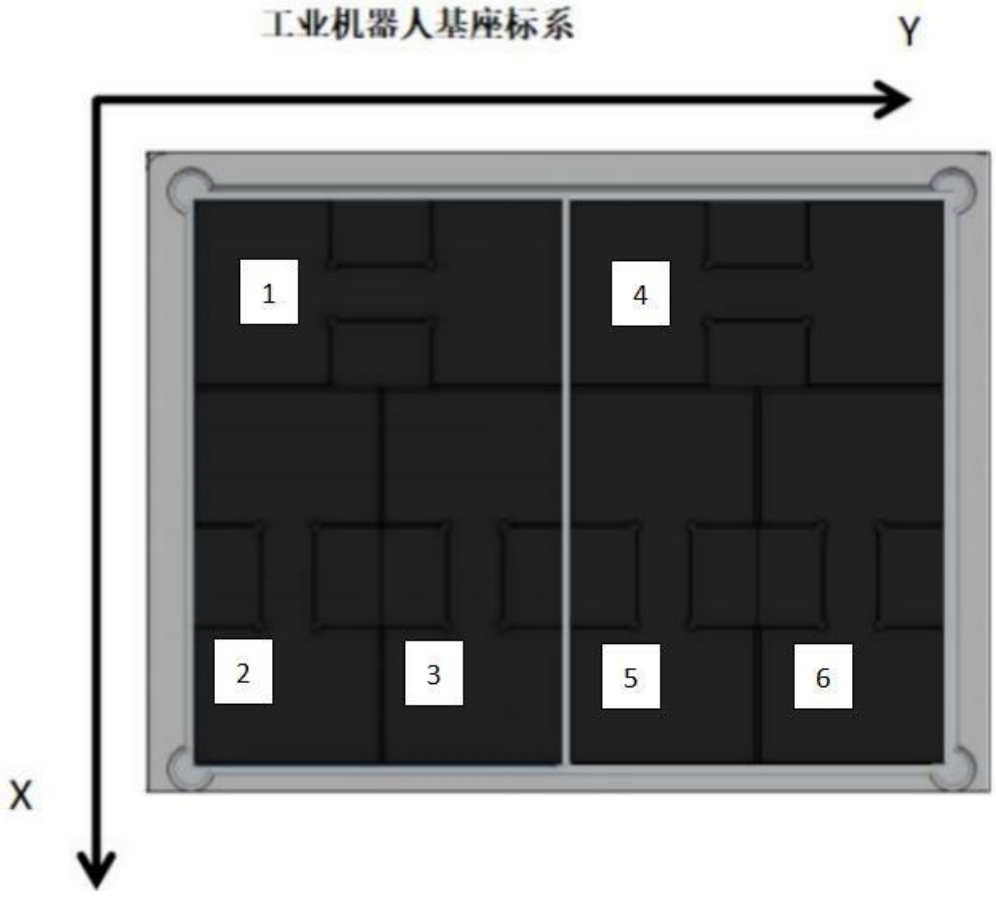

Figure 4-2 Type requirements

NO.3 Special-shaped chip detection and assembly, offline programming and debugging

In PQFactory software, complete the action track of industrial robot alien chip detection and assembly, the specific requirements are as follows:

1. Industrial robots start to run from the safe point Home point;
2, industrial robot installation of suction cup tools;
3. The industrial robot can put the chip according to the material plate number (shown in Figure 4-3), grab the chip and put it in the A06 product board of station 1 and A04 product board of station 2 (shown in Figure 4-4), (each chip needs to be detected on the visual camera of the detection unit for simulation detection. During detection, the highest height of the bottom surface of the limit chip from the light source is h=50 mm, and stay at this point for 2 seconds);
4. Industrial robots will return to the safety point Home point.

Figure 4-3 Location number of material plate chips

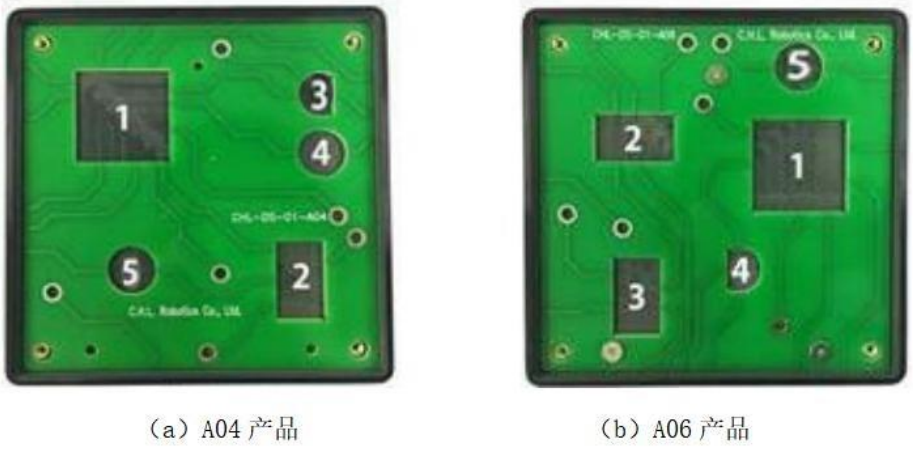

Figure 4-4 Product chip position number diagram

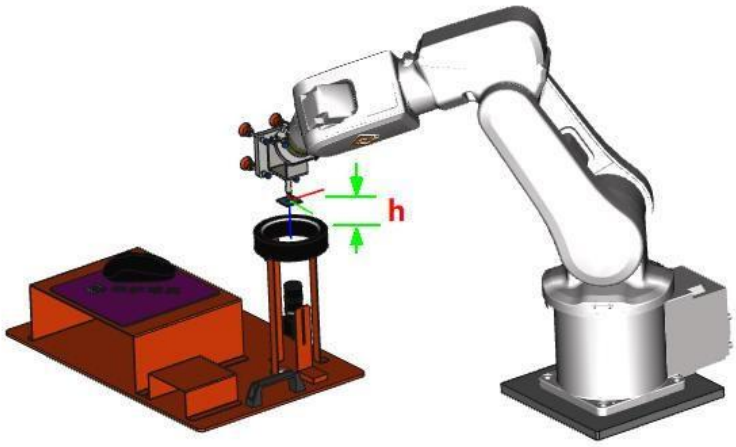

Figure 4-5 Location plot of visual detection

NO.4 Offline programming and debugging of the product cover plate assembly

In PQFactory software, complete the action track of cover plate assembly of industrial robot products, the specific requirements are as follows:

1. Industrial robots start to run from the safe point Home point;
2. The industrial robot picks up the cover plate and instit into the product board of station 1 and 2 respectively;
3, industrial robot release sucker tools;
4. Industrial robots will return to the safety point Home point.

NO.5 Offline programming and debugging of multiple process processing tracks

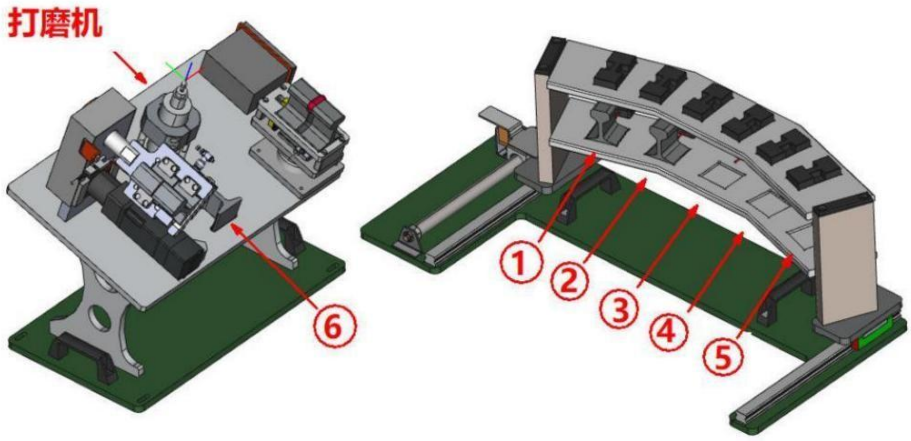

Figure 4-6 Multi-process processing unit diagram

In PQFactory software, complete the multi-process processing track of industrial robots, the specific requirements are as follows:

1. Industrial robot starts running from the safety point Home point; Note: The initial stereo warehouse stage sliding mechanism status machine is in the launch position (state 1)
2, industrial robot installation claw tools;

3. The industrial robot grabs the rough parts of the guide rail from the position 2;

4, will not be covered by the claw side, grinding to burr;

5. After polishing, place it at the position of 4 in the lower layer of the three-dimensional warehouse;

6, the industrial robot release claw clip tool;

7. Industrial robots return to the safety point Home point.

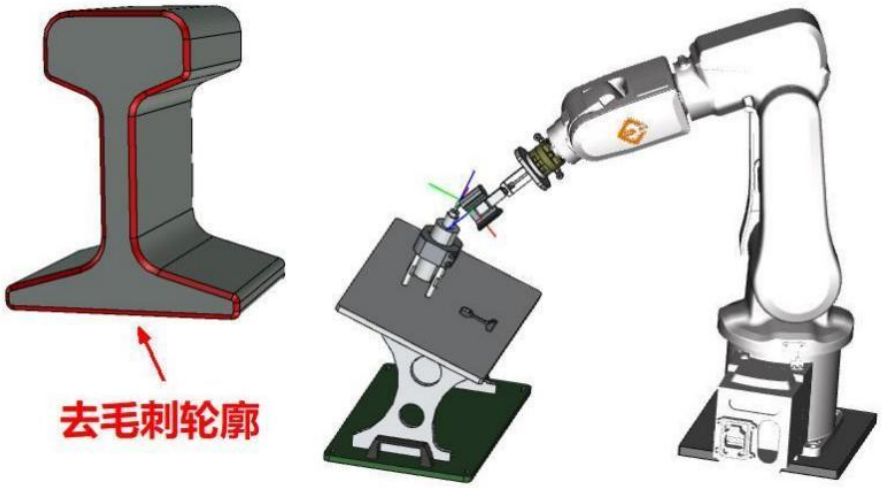

Figure 4-7 Schematic representation of the deburring area

Task 5 Virtual debugging of integrated system

Using PLC module, program in PLC programming software, complete the MES system ordering, PQFactory software virtual debugging and other tasks.

(I) PLC program programming

Write a PLC program for virtual debugging to implement the following functions:

1. It can control the extension and traction of the three-dimensional warehouse platform, and cooperate with industrial robots to complete the process of stacking and disassembly;

2. After the industrial robot completes the chip assembly, the control station 1 pushes the cylinder retracted. After the retracted in place, the lifting cylinder drops. Station 1 test is completed, control station 2 push the cylinder retracted, retracted after the lifting cylinder down, detect the LED light often on for 4s, the lifting cylinder up, push the cylinder out, the result indicator light is on, OK state.(There are two kinds of test results, namely finished product OK and waste product OK; OK, green indicator goes out for 5s and red indicator is on for NG)

3. Run IOServer software to realize communication with PLC module.

4. Run PQFactory software, connect to PLC, and can realize virtual debugging;

(2) Program adjustment of industrial robots

In PQFactory software, the robot simulation track generated by task 4 is synchronized, and the robot program is edited and modified: main program, control signal and judgment logic are

added, so that the workstation can run the entire process of virtual simulation debugging.

(3) Touch screen screen drawing

The main interface of the screen contains three keys: "start1", "start2" and "start3", which are associated with the PLC signal, requiring the picture to be clean and beautiful.

(4) System joint adjustment

In PQFactory software, add three signals: "start1", "start2", "start3", address customization, control "start1" as TRUE on touch screen during virtual debugging, start running stack disassembly process; control "start2" as TRUE on touch screen, start running assembly process of chip assembly and product cover; control "start3" as TRUE on touch screen, and start to run grinding and burr process.

BRICS