2026

# BRICS SKILLS COMPETITION

## (BRICS+ FUTURE SKILLS & TECH CHALLENGE)

# Industrial Robot Digital Twin Technology Application

BRICS-FS-40

## Test Project

(Online_International Final)

June, 2026

# Module A Virtual debugging of industrial robot systems

## A-1 Simulation Environment Setup

### （一）Scene Creation

Use PQFactory software to open the CHL-DS18.robx file and open the display interface as shown in Figure 1-1. According to the installation steps, assemble each unit of the workstation into Figure 1-2.

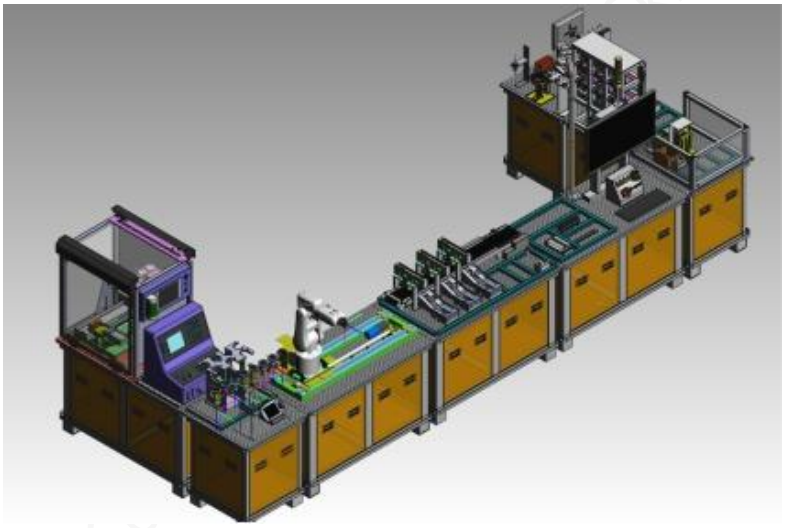

Figure A-1 PQFactory file

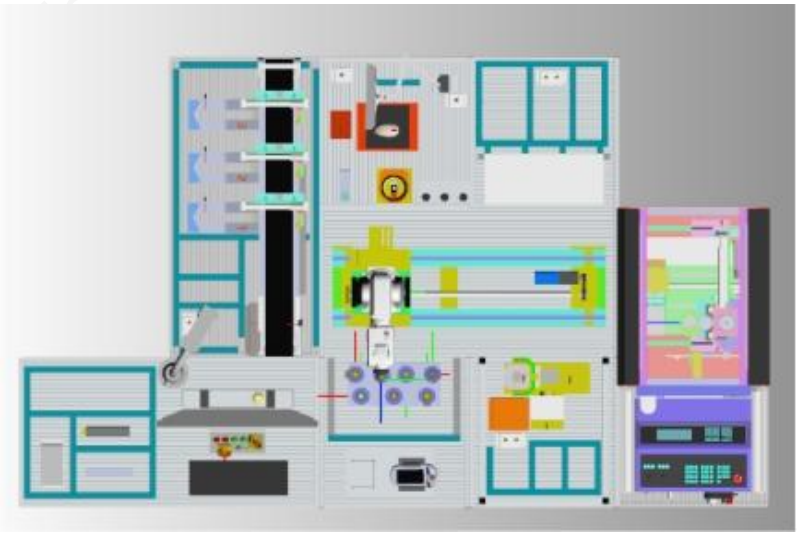

Figure A-2 Top view after assembly

**requirementof assembling ：**

1. Using the "Execution Unit" as the reference and each processing unit as the basic unit, assemble all work units;

**2.** During assembly, the side surfaces of the tabletop panels of each processing unit must fit together precisely, ensuring all table planes remain coplanar (as shown in Figure 1-3);

**3.** Fast-change tools on the Tool Unit should be installed at appropriate locations on the tool rack according to requirements.

**（二）Workstation Model Definition**

1. In the virtual simulation system, define photoelectric sensors at Storage Unit No.2 and No.5 workstations to enable detection functionality, allowing them to identify product components at respective stations and associate with corresponding variables.

2. In the virtual simulation system, define the color states of the red and green indicator lights for Storage Unit No.2 and No.5 workstations: display green when materials are present and red when no materials are present, with corresponding variables linked accordingly.

3. In the virtual simulation system, define the state machines for Storage Unit 2 and Storage Unit 5 pallets. Under the "Scene" model, locate the assemblies "Storage-Pallet 2" and "Storage-Pallet 5", define them as state machines named "Storage-Pallet 2 State Machine" and "Storage-Pallet 5 State Machine", set their movement mode to "Translation" with a minimum displacement of 0 mm and a maximum displacement of 125 mm, ensuring the direction aligns with the actual cylinder movement; define two states: State 1 (retracted position) with a movement duration of 0s and joint displacement of 0 mm, and State 2 (extended position) with a movement duration of 1s and joint displacement of 125 mm.

4. Define variables for the state machine, indicator lights, sensors, rails, and other components of the virtual simulation workstation. Users may define their own variable addresses.

5. Correctly configure the virtual simulation workstation snapshot to reflect the workstation's initial state.

## A-2 Manual Debugging of the Integrated System

Complete the address configuration and communication settings for PQFactory to enable external signal communication with the PLC control box. Implement manual control of the virtual scenario via PLC programming. Requirements are as follows:

1. Operate switch button 1 to extend/retract the storage unit station 2's telescopic cylinder;

2. Operate switch button 2 to extend/retract the storage unit station 5's telescopic cylinder;

3. Press the "Start" button on the training box to illuminate green indicator lights at stations 2 and 5;

4. Press the "Stop" button on the training box to illuminate red indicator lights at stations 2 and 5.。

Note: The PLC addresses for the PLC control box are listed in Table A-1.

Table A-1

| order number | address | function annotation | order number | address | function annotation |
|---|---|---|---|---|---|
| 1 | Q0.0 | Activate the indicator light | 1 | I0.0 | start button |
| 2 | Q0.1 | Reset indicator light | 2 | I0.1 | stop button |
| 3 | Q0.2 | Turn off the stop light | 3 | I0.2 | reset button |
| 4 | Q0.3 | buzzer | 4 | I0.3 | scram button |

| | | | | | |
|---|---|---|---|---|---|
| 5 | - | - | 5 | I0.4 | Turn on switch 1 |
| 6 | - | - | 6 | I0.5 | Move switch 2 |
| - | - | - | 7 | I0.6 | Move switch 3 |
| - | - | - | 8 | I0.7 | Move switch 4 |
| - | - | - | 9 | I1.0 | Diffuse reflection photovoltaics1. |
| - | - | - | 10 | I1.1 | Diffuse reflection photovoltaics2. |
| - | - | - | 11 | I1.2 | Slot photoelectric |
| - | - | - | 12 | I1.3 | proximity switch |
| - | - | - | 13 | I1.4 | safety protection device |

# A-3 Integrated System Virtual Debugging

### （一）HMI Interface Programming Design

1、Design an HMI monitoring interface that displays the open/closed status of the safety door on the left side of the machine tool, monitors the status of hubs 2 and 5 in the storage unit, and tracks the current position of the industrial robot's guide rail.

2、Design an automated HMI process interface. On the HMI screen, users can select either the Assembly Logo (Option 2 or Option 5), choose a process branch, and proceed to either the left branch (sort hub) or the right branch (hub return). Add an "Auto Start" button on the HMI interface.

### （二）Virtual Debugging Process and Debugging Methods

According to the process requirements shown in Figure A-3, develop a PLC program and a virtual simulation program for the industrial robot, enabling final virtual debugging and operation of the entire process flow. Based on the initial characteristics and state information in Table A-2, adjust the positioning of wheel hubs and vehicle logos on the workstation to complete the virtual debugging of the production process

for a single wheel hub component.

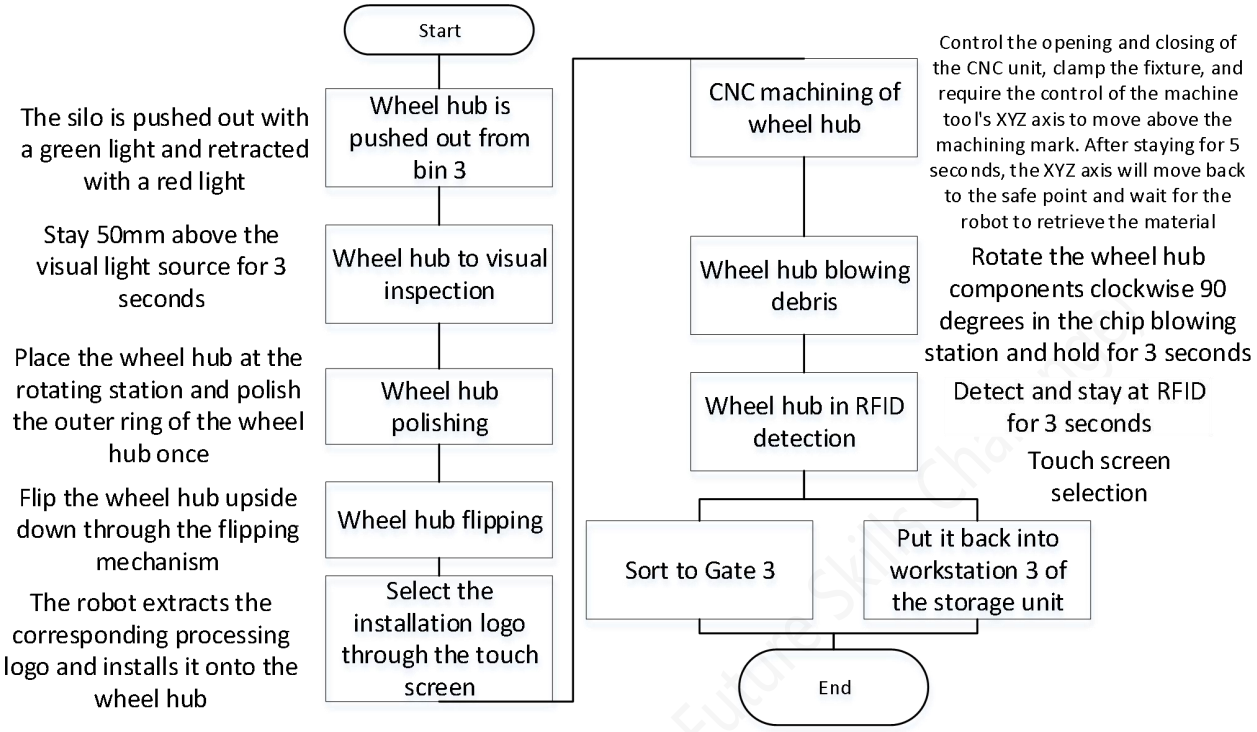


Figure A-3 Process flow chart

able A-2 Initial state of the virtual debugging process hub

| The hub is placed in its initial position | Whether to install the car logo | Rim placement direction |
|---|---|---|
| Bin 2 | not have | Face down |