Test Project (Offline)

BRICS-FS-23_Industrial Digital Twin

2022 BRICS Skills Competition

Project Description：

BRICS Skills Competition - offline finals of Industrial Digital Twin Project will be held in pairs

Competition time: 4 hours in total

The test project consists of five modules

The event is based on the planning, implementation and optimization of digital production line. It mainly assesses the competitors' use of simulation technology and digital twin platform to build, operate and maintain digital twins, and complete the plant layout design, production line commissioning, digital control and performance optimization of digital production line.

The test items include the following, and the installation and debugging of digital twins and modules in virtual and real world need to be completed:

1. Digital production line design
2. Digital production line programming and debugging
3. Customized production
4. Virtual and actual joint commissioning of digital production line
5. Digital production line optimization

The total score of the project/module is 100.

The score proportion is as follows

Item	Name	Total evaluation score
Module A	Digital production line design	10
Module B	Digital production line programming and debugging	30
Module C	Customized production	20
Module D	Virtual and actual joint commissioning of digital production line	20
Module E	Digital production line optimization	15
	Professional quality	5
Total		100

matters needing attention:

1. The program files created by contestants during the competition must be stored in the folder "D: Skill Competition Station Number".

2. The position, sensitivity, throttle valve opening, driver and instrument parameters of the sensor shall be adjusted by the contestant according to the use conditions.

3. Damage to industrial robots and I/O components, vision systems, PLC, motors and drivers caused by improper operation will be handled according to the deduction table.

4. During the competition, the computer data should be saved in time to avoid data loss due to power failure and other accidents.

5. The competition provides electrical schematic diagram, pneumatic schematic diagram, device manual and other relevant materials.

Module A: Digital production line design

（1） Task description:

According to the given 3D model, complete the creation of digital birth line twins; Complete the model building, parameter setting and verify the correctness of the results according to the production process flow; Combined with the digital twin platform, the virtual debugging and digital simulation verification technology are used to complete the debugging optimization and functional verification of the digital twin of the electromechanical drive control part;

Commissioning includes the following contents:

1. Virtual scene model building

2. Establishment of model parameters and signal configuration

3. Complete the process path planning of industrial robot

4. Virtual device debugging and verification

（2） Project and task description:

Project 1. Virtual scene model building

1. According to the 3D mechanical model provided, complete the construction of 3D twin scenes of the feeding and filling station and the robot assembly station respectively.

2. Adjust the position of each work unit of the workstation and reasonably arrange it on the workbench

Table 1-1 Mechanical modules to be adjusted.

Code	Item	Pic	Qty
1	Electric manipulator module (feeding and filling station)		1
2	Bottle cap rack module (robot assembly station)		1
3	Stereoscopic storage module (robot assembly station)		1

The finished renderings are as follows:

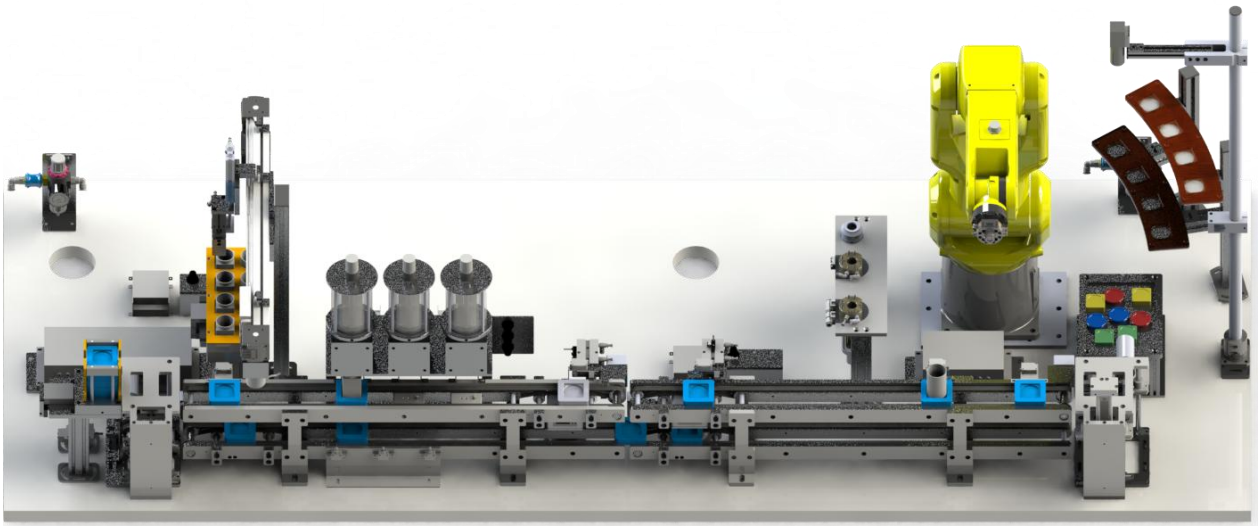

Figure 1-1 Reference Layout of Digital Twin 3D Model

Item 2. Model motion parameter establishment and signal configuration

Analyze the motion relationship of the component mechanism, reasonably set the motion mechanism, and create the correct position and attitude.

1. Define the round bottles (4) and square bottles (4) in the feeding and filling station as parts and put them into the 8 bins of the "bottle feeding" module accurately.

2. Set the "bottle feeding module", "pallet feeding module", "lifting platform (left)", and the five stop mechanisms (1 bottle stopper, 3 weighing stopper, and 1 pusher stopper, as shown in Figure 1-2) on the upper layer of "two-layer transmission module 1" of the feeding and filling station as reasonable operating mechanisms, and create correct position and posture; Add logic resources, create IO bit signals to control cylinder action, and add feedback signals of cylinder position according to electrical drawings. The photoelectric sensor signal is added at the corresponding photoelectric sensor position to detect whether the tray or parts are in place or not.

3. Set the "electric manipulator module" of the feeding and filling

station as a reasonable movement mechanism to enable it to grasp parts (workpieces); Add logic resources and create IO bit signals to control cylinder action and feedback position signals. Motor position control and position feedback are real signals.

4. Define the round bottle caps (4) and square bottle caps (4) of the robot assembly station as parts, set the color of round bottle caps to red (2) and blue (2), and set the color of square bottle caps to yellow (2) and green (2).

5. Set the "pneumatic gripper" and "single suction cup clamp" of the robot assembly station as tools, and reasonably set the attribute parameters and posture.

6. Define the "industrial robot module" of the robot assembly station as a robot, set the kinematic attributes and related parameters, and create the robot default signal.

7. Set the three stop mechanisms on the upper layer of the "two-layer transmission module 2" of the robot assembly station (flat push stop, cover stop, incoming stop, as shown in Figure 1-3) and "lifting platform (right)" as reasonable motion mechanisms, and create correct position and posture; Add logic resources, create IO bit signal to control cylinder action, and add feedback signal of cylinder position. The photoelectric sensor signal is added at the corresponding photoelectric sensor position to detect whether the tray or parts are in place or not.

8. Other modules or components not listed shall be set according to the simulation operation effect.

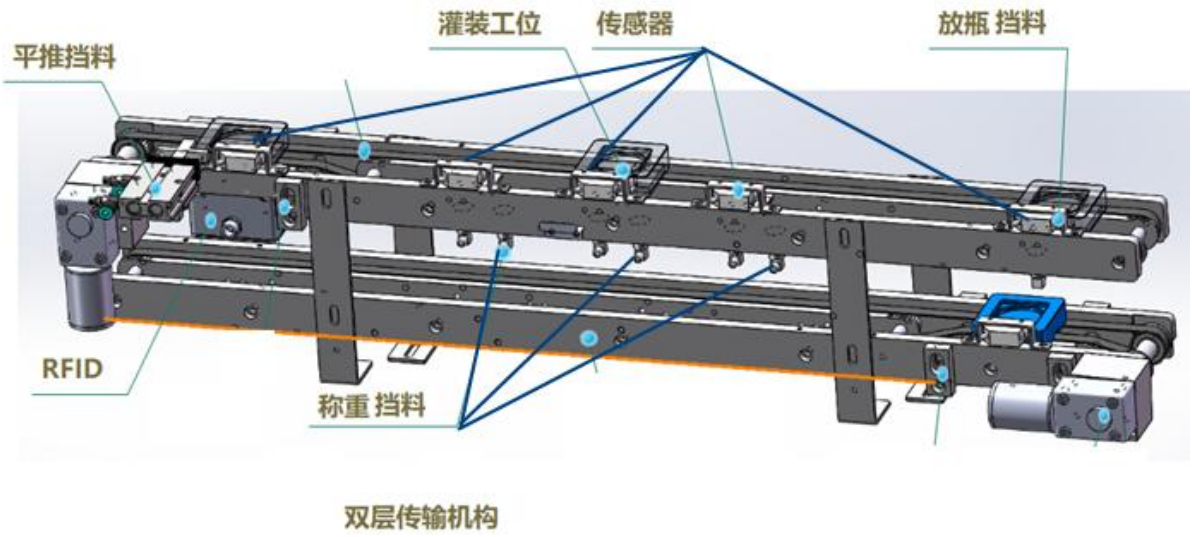

Figure 1-2 Description of Mechanism Components of Double Layer Transmission Module 1 (Feeding and Filling Station)

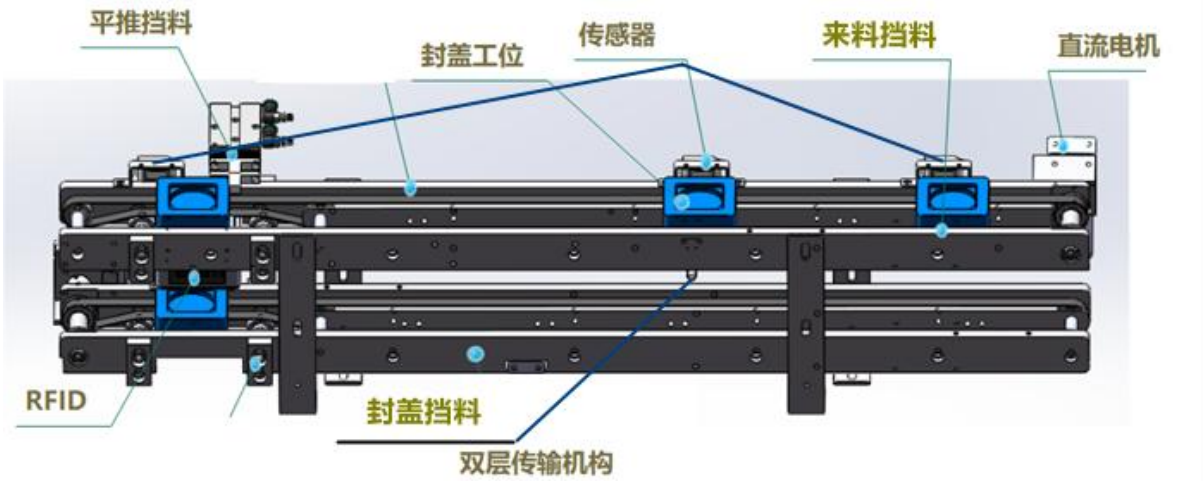

Fig. 1-3 Description of mechanism components of two-layer transmission module 2 (robot assembly station)

Project 3. Complete the process path planning of industrial robots

1. Set the robot path, and complete the robot automatic picking and placing fixture, cover and finished product warehousing process.

2. Automatically generate robot programs and set program numbers for each robot program.

Item 4. Virtual equipment debugging and verification

1. Use the simulation panel to test the action and corresponding position signal status of the 8 modules of twins required by item 2 (randomly designated by the judge during evaluation).

2. Use the simulation panel to test the twin robot program function required by item 3.

Module B: Digital production line programming and debugging

（1） Task description:

This task mainly assesses the establishment of the digital factory physical model, completes the interconnection between the actual PLC and the digital factory production line network, and debugs and verifies the operation stability of the digital factory physical production line;

Commissioning includes the following contents:

1. Hardware adjustment and parameter setting
2. Programming and debugging
3. Manual test run
4. Customized production operation of touch screen

（2） Project and task description:

Item 1. Hardware adjustment and parameter setting

1. After the equipment is transported to the customer's site, some mechanical modules and electrical components need to be overhauled, debugged and optimized on site, and the contestants need to adjust themselves according to the use situation. After adjustment, the equipment shall be ventilated. Adjust the air supply pressure to 0.4-0.6Mpa.

2. Other parts not listed shall be adjusted by the contestants according to the use conditions.

Item 2. Programming and debugging

1. Compile robot and vision system programs, complete robot vision positioning and grasping, and realize robot picking and placing tools, covers and finished products warehousing process.

2. Prepare comprehensive communication programs such as touch screen, PLC, RFID, robot, camera, etc. to complete the tasks of bottle feeding, transmission, material filling, bottle capping, and finished product warehousing of the production line. The network topology is shown in Figure 2-1.

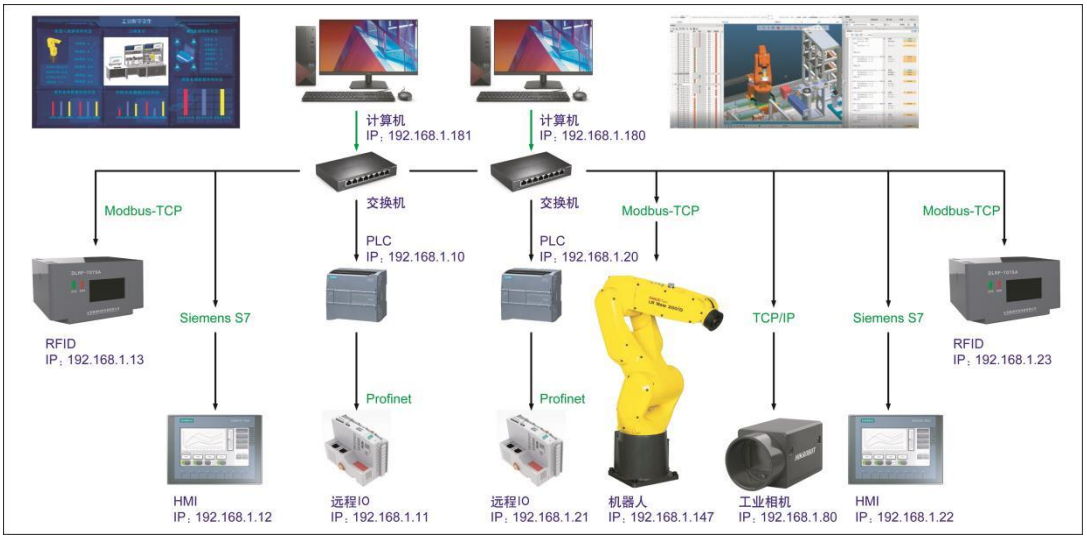

Figure 2-1 Network topology

3. The touch screen of the feeding and filling station contains two screens, namely the "manual operation" page and the "order" page, and can complete the switching of different pages, as shown in Figure 2-2 and Figure 2-3.

The "Manual Operation" page on the touch screen of the robot assembly station is shown in Figure 2-4.

Item 3. Manual test run

1. Operate the button corresponding to the "Manual Operation" page on the touch screen of the feeding and filling station, which can control the

retraction of the "Pallet Feeding Cylinder", the retraction of the "Bottle Feeding Cylinder", the lifting of the "Lifting Platform (Left)", the five stop cylinder actions of the "Double Layer Transmission Module 1" (1 bottle stopper, 3 weighing stopper, and 1 flat pusher stopper), and control the forward and reverse rotation of the "Lifting Platform (Left)" motor The start and stop of six motors in the filling module (three screw motors and three mixing motors) and the start and stop of two transmission motors in the "two-layer transmission module 1" (upper and lower motor) can control the horizontal, vertical and clamping release movement of the electric manipulator, and can display the data of the weighing sensor, the position data of the gantry manipulator, and the current position data of the encoder in real time, and can complete the RFID data reading and writing function of the feeding and filling station. The picture is shown in Figure 2-2.

2.2. Operate the button corresponding to the "Manual Operation" page on the touch screen of the robot assembly station to control the lifting of the "lifting platform (right)", the action of the three stop cylinders of the "two-layer transmission module 2" (1 flat push stop, 1 cover stop, and 1 upper stop), the forward and reverse rotation of the "lifting platform (right)" motor, and the start and stop of the two transmission motors of the "two-layer transmission module 2" (upper and lower motor), It can also read and write the RFID data of the robot assembly station, as shown in Fig. 2-4.

Fig. 2-2 Manual Operation Page of Feeding and Filling Station

Figure 2-3 Order Page of Touch Screen

Fig. 2-4 Manual operation page of robot assembly station

Item 4. Customized production operation of touch screen

1. Before the equipment runs, the contestant puts 4 pallets into the bin of the pallet feeding module, places the bottle (4 squares and 4 circles) into the 8 station slots of the bottle feeding module, and empties the rest of the workpieces on the operating platform;

2. Operate the touch screen "Order Page" to complete the order setting and issuing (the judge will randomly assign two orders during the evaluation). The order contents are respectively the type of bottle (round bottle and square bottle), the material color (yellow, red and black), the material weight (set range 1-50g), the bottle cap color (round bottle cap is 2 red and 2 blue, square bottle cap is 2 yellow and 2 green) and the warehousing number (set range 1-8).

3. After the order is generated, the production line will automatically complete the tasks of bottle feeding, transmission, filling, capping and finished goods warehousing. It is required that the operation is smooth and smooth, and no score will be given if the order is not taken and placed in place. The process is shown in Figure 2-5.

be careful:

1. The contestants shall be ready to judge according to the task requirements.

2. Competitors can prepare workpieces before scoring. However, it is not allowed to modify, download programs, teach points and other operations.

3. Only one demonstration.

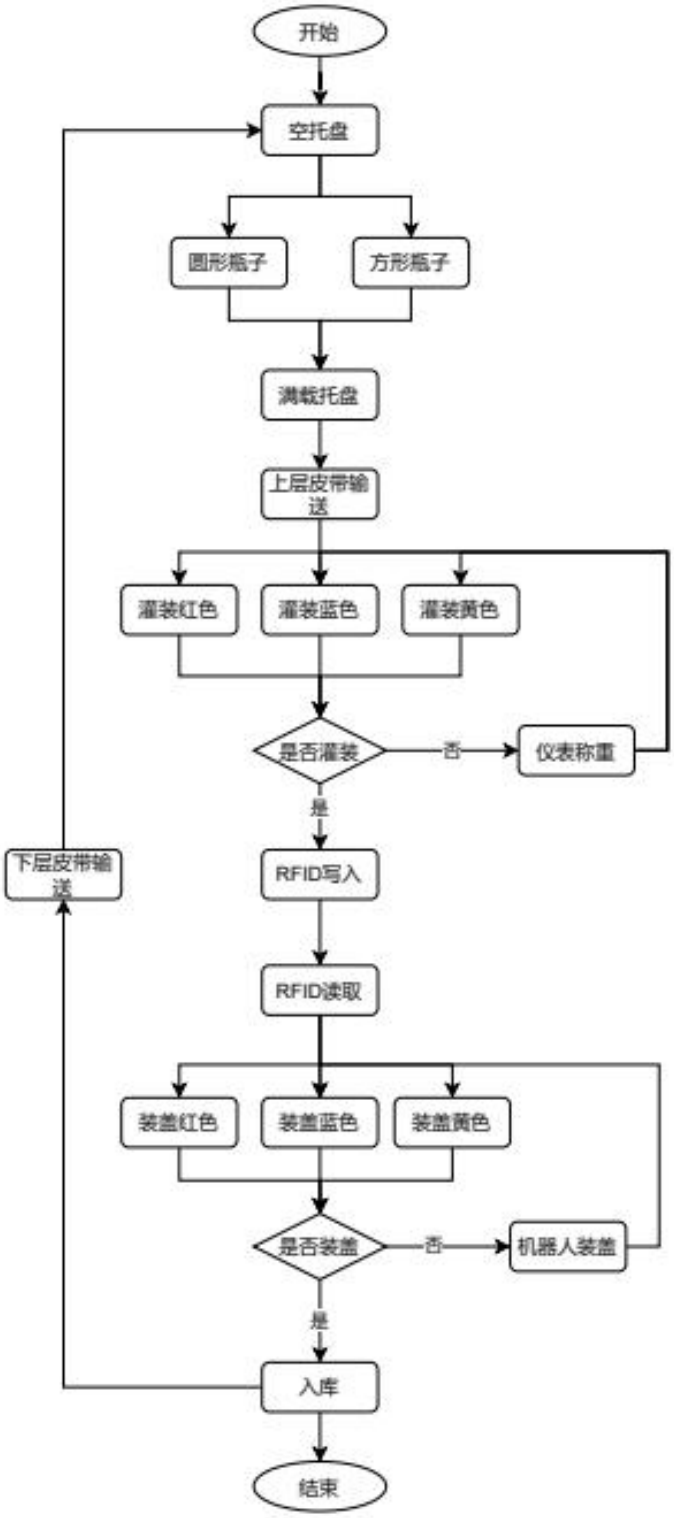

Figure 2-5 Flow Chart of Production Line

Module C: Customized production

（1） Module introduction:

Combined with the manufacturing execution system MES, network communication technology is used to collect data information, optimize the production process and rhythm, and complete personalized customized production tasks.

Commissioning includes the following contents:

1. MES system data processing

2. MES Kanban data display

3. MES order distribution

（2） Project and task description:

Item 1. MES system data processing

1. Complete the network communication settings between MES and PLC, robot and other equipment

2. Add and improve PLC program to realize data exchange between MES and PLC

Item 2. MES Kanban Data Display

1. The MES board can display real-time robot joint data, Cartesian coordinate data, real-time position of electric (gantry) manipulator, real-time data of weighing sensor, finished product bin information, progress information of production process of feeding and filling station and robot capping station.

2. The wide screen of the feeding and filling station displays the MES order page and the MES kanban page in real time at the same time.

3. The wide screen of the robot assembly station displays twin images and 2D vision system images in real time.

Item 3. MES Order Issuing

1. Before the equipment runs, the contestant puts 4 pallets into the bin of the pallet feeding module, places the bottle (4 squares and 4 circles) into the

8 station slots of the bottle feeding module, and empties the rest of the workpieces on the operating platform;

2. The "Manual/Automatic" knob on the operation panel is in the automatic mode;

3. Operate the MES "Order Page" to complete the order setting and distribution;

4. The production line runs automatically to complete customized production tasks such as bottle feeding, transmission, filling, capping, and warehousing of finished products. The process is shown in Figure 2-5.

Module D: Virtual and Actual Joint Commissioning of Digital Production Line

（1） Module introduction:

This module combines the digital twin and production line physical platform to complete the interconnection and intercommunication of digital production line twin data and actual production line data information.

Commissioning includes the following contents:

1. Network interconnection

2. Data acquisition

3. Virtual reality linkage

（2） Project and task description:

Project 1. Network interconnection

1. Complete network communication between digital twin and physical production line

2. Complete real-time interaction between digital twins and actual PLC data information

Item 2. Virtual reality linkage.

1. Supplement and improve the PLC program, and complete the virtual and real linkage data docking between the feeding filling station and the robot assembly station.

2. Process and link the collected information to each movement mechanism of the twin.

3. Optimize the twin model properties and parameters, so that the twin model running state is synchronized with the actual production line, and the state is consistent (the robot action can not do virtual real synchronization, but the action process must be consistent).

4. The system runs automatically. The MES is operated to place an order. First, the feeding and filling station operates with virtual and real linkage. After the feeding and filling is completed, the tray enters the robot assembly station, which operates with virtual and real linkage to complete the capping and warehousing tasks. The process is shown in Figure 2-5.

Module E: Digital production line optimization

（1） Module introduction:

According to the process flow and beat requirements, optimize the production process and beat of the digital production line, and improve the production efficiency and product quality.

Commissioning includes the following contents:

1. Production efficiency data collection and analysis

2. Improvement of production efficiency

（2） Project and task description:

Item 1. Production efficiency data collection and analysis

By adjusting PLC and robot program, the speed and production rhythm are optimized, and the waiting time is reduced. Improve productivity.

Item 2. Improvement of production efficiency

The specific workflow is as follows (**all are completed under automatic status**):

1. Be able to complete the feeding, filling, capping and warehousing according to the MES order (2 orders, when judging, the player sets the order content according to the referee's instructions);

2. The equipment operates stably without jamming and midway shutdown;

3. There is no damaged workpiece (not in place);

4. The final running speed of the equipment shall be optimized by the contestants themselves;

5. When the referee scores, the player will place an order according to the referee's requirements, and the player will only demonstrate the operation process once