

Virtual Simulation Development of ABB Industrial Robot Technology

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ABSTRACT. Based on unity3D, an industrial robot application simulation teaching platform is designed to solve the problems of high cost and limited quantity of robot equipment introduction in the current industrial robot teaching. By restoring the real five processes of stacking, grinding, vision, assembly and warehouse storage of industrial robot, not only the teaching efficiency of teachers is improved, but also the robot teaching efficiency of students is improved. Level of understanding and practice.

KEYWORDS: Unity3D, industrial robot, virtual simulation, programming application

1. Introduction

With the proposal of "Made in China 2025", the popularization of automation makes the application of industrial robots in production and life more and more extensive, and the social demand for new application-oriented talents related to industrial robots is also growing [1-2]. In recent years, colleges and universities around the world have set up industrial robot technology specialty to train industrial robot application talents for the society. Due to the large number of industrial robot brands, high equipment price and effective quantity, the teaching mode of robot only stays in books and teacher demonstration, and students lack the process of hands-on operation, which leads to the phenomenon that theoretical knowledge and practical operation are separated. Therefore, how to balance the contradiction between the teaching cost and the learning effect of students has become an urgent problem to be solved in the current industrial robot teaching [3].

Virtual simulation technology effectively solves the above problems. By simulating the real operation situation, students can practice repeatedly in the virtual environment, not limited by time and place. At the same time, it can quickly create industrial robot system in simulation software, reproduce various scenes, and meet the application of industrial robot in different aspects [4].

In this paper, aiming at the existing teaching platform of industrial robot application in the school, a simulation teaching platform of industrial robot application is designed by using robot studio simulation software, so that students can master off-line programming, including the use of smart components, the creation and link of input/output signals, the debugging of programs and the verification of simulation.

A complete industrial robot system includes the main body, servo motor, reducer, teaching device, driver, controller and its peripheral equipment, such as camera, I/O module, etc [5]. it is the key component to realize automatic production. Before building a 3D model, we need to collect all kinds of data parameters on the platform to build a 1:1 3D model and truly restore the industrial robot peripheral equipment. In order to facilitate the use of teachers, the platform is the smallest irb120 industrial robot of ABB Company. The simulation of appetizing, grinding, vision, assembly and storage can meet the needs of students to learn the theory and practice of industrial robots from multiple angles and levels. The working radius of irb120 is 580mm, and the rotation range of axis 1 is + 165 - 165, which can cover the working area of the whole hexagonal table. Irb120 robot can directly import this type of industrial robot from the model library, as shown in Figure 1 is the working area of industrial IRB 120 robot.

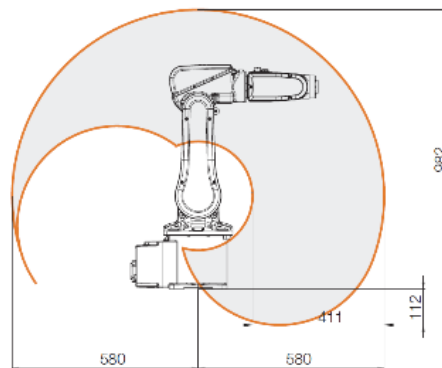


Figure. 1 IRB120 robot working area

The realization of various functions in the automatic production process is inseparable from different mechanical devices, which plays a key role in the completion of the five tasks in the whole workstation, and directly affects the step planning and presentation effect of each task. In this workstation, except for the industrial robot model, the other peripheral models need to be rebuilt. Simple components such as materials, parts and suction cups can be realized by selecting the modeling function in the simulation software; relatively complex peripheral devices such as fixtures and hexagonal tables need to draw 3D solid models through NX professional software. For the mechanical devices that need to be moved in production, such as clamps of different sizes and the tension of clamps, it is

necessary to create a mechanical device to realize reciprocating motion, and adjust the posture according to the size of the actual material to achieve the grasping action. The platform has 5 mechanical devices, including 2 suction cups and 3 clamps. Use smart components to create 5 sets of device components, simulate and debug each device component one by one to meet different tool functions of stacking, grinding, vision, assembly and storage [6].

2. Design of industrial robot application simulation platform

2.1 basic process of industrial robot application platform

According to the counter clockwise direction of the hexagonal table, the working process of ABB industrial robot application platform is summarized in sequence:

(1) When the robot moves to the initial position of stacking, the suction cup is installed. 1. The robot sucks the trapezoidal materials from the reservoir area (8 trapezoidal materials are placed at a time, and the materials can be placed randomly). After being placed in the positive and negative detection areas, the robot will put the materials into the left and right respectively after judging by the program. Sorting areas. After 8 times of judgment, the robot places suction cup 1 in situ and returns to the initial position of stacking.

(2) when the robot moves to the initial position of grinding, install the clamp 2. The robot picks up materials from the reservoir area and then grinds them. After the grinding, the robot places the clamp 2 in situ and returns to the initial position of stacking.

(3) when the robot moves to the initial position of vision, install the sucker 3. Take photos by the camera to determine the position of each jigsaw in the reservoir area. After the program judgment, the sucker successively absorbs the jigsaw and places it on the right jigsaw to complete the jigsaw puzzle. The robot places the sucker 3 in situ to return to the initial position of vision.

(4) the robot moves to the initial position of the assembly, installs the clamp 4, and then grabs and places the base, bearing, cushion block and nut on the assembly platform in turn, and then tightens them through the electric screwdriver. The robot places the clamp 4 in situ, and returns to the initial position of the lock wire assembly.

(5) when the robot moves to the initial position of the storage, when the photoelectric switch detects the wheel transmitted by the conveyor belt, the robot grabs the wheel according to the program, and then puts the wheel into the corresponding storage area through judgment, and the robot places the clamp 5 in situ, and returns to the initial position of the wheel storage. After completing the above five tasks, the robot returns to its initial state. Figure 2 is a real robot application teaching platform [7].

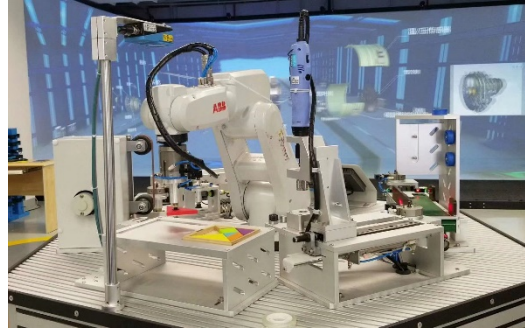


Figure. 2 real robot application teaching platform

According to the teaching requirements, the robot can automatically complete five tasks in turn, and at the same time, it can choose to issue five different tasks, which can be executed separately. The main program is as follows, corresponding to the flow chart of the workstation in Figure 3.

```
PROC main()#Main function #
  rInitAll; # Initialization #
  WHILE TRUE DO
    WaitUntil PN_GIJobNumber<>0;
    nProNO:=PN_GIJobNumber;
    TEST nProNO
CASE 1: MaDuo; # Task issuing and stacking station #
  Waituntil PN_GIJobNumber=0;
CASE 2: DaMo; # Task distribution grinding station #
  waituntil PN_GIJobNumber=0;
CASE 4: ShiJue; # Visual station of task distribution #
  waituntil PN_GIJobNumber=0;
CASE 8: ZhuangPei; # Task distribution and assembly station #
  waituntil PN_GIJobNumber=0;
CASE 16: CangChu; # Task distribution storage station #
  waituntil PN_GIJobNumber=0;
  DEFAULT:
stop;
    EXIT;
  ENDTEST
  endwhile
ENDPROC
```

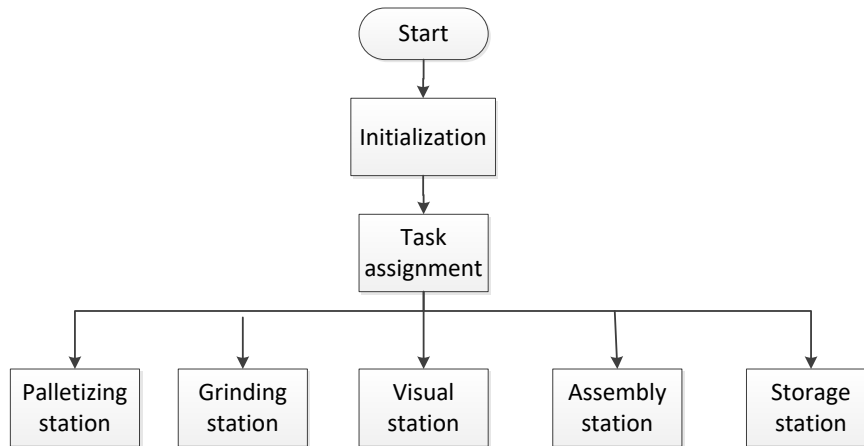


Figure. 3 flow chart of workstation

2.2 I / O signal of industrial robot system

Siemens plc1500 is selected as the central control system of the robot application teaching platform. The communication between plc1500 and robot irb120 is realized by PROFIBUS. However, in the robot Studio software is different from the real situation, the simulation process can use smart components instead of PLC to simulate the real data communication. The realization of various functions requires the creation of different smart components to control. Each component is equipped with I / O ports. The simulation can be realized only when each component is finally connected with the robot system in the workstation logic [8].

Therefore, after the whole model is built, it needs to complete the following steps:

- (1) Create smart components and complete signal connection.

Take suction cup 1 of palletizing station for example, planesensorgripper, attacher, logicgateteach [not], detacher and logicsrlatchattached need to be added to the suction cup to realize two actions of suction cup 1: material suction and material placement. The design of suction cup 1 component is shown in Figure 4. When the surface sensor on the suction cup detects the material, set 1, and the suction cup absorbs the material. When the surface sensor on the suction cup is set to 0, the material is placed.

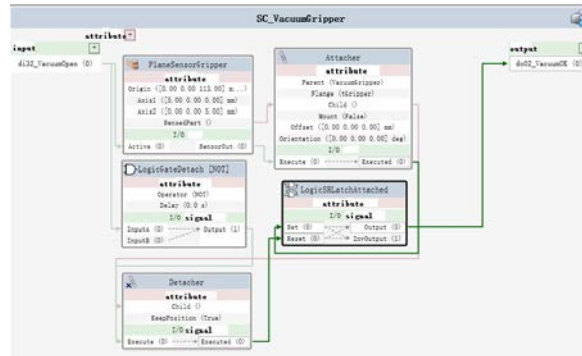


Figure. 4 design drawing of suction cup 1

(2) I / O signal is set. Dsqc652 I / O board is selected in this workstation. The communication board can provide 16 digital input signals and 16 digital output signals respectively. Some I / O signals used in this design are shown in Table 1.

Table 1 Main I / O signals

Signa name	Signal type	address	Explain
DI1	Digital signal input	0	Appetizing suction cup detection
DI2	Digital signal input	1	Grinding fixture inspection
DI3	Digital signal input	2	Visual sucker detection
DI4	Digital signal input	3	Assembly fixture inspection
DI5	Digital signal input	4	Inspection of storage fixture
PN_ GIJObNumber	Group signal input	11-15	Task publishing station
DO2	Digital signal input	1	Clamp release
DO3	Digital signal input	2	Fixture clamping

(3) Create the workstation logic and connect the input and output signals of the system with each smart component.

2.3 Programming of industrial robot

Robot studio uses rapid programming language. Continue to take palletizing station as an example, 2.1 summary has introduced the execution process of industrial robot palletizing station, as shown in Figure 5 is the solid palletizing station. The whole work flow is shown in Figure 6.

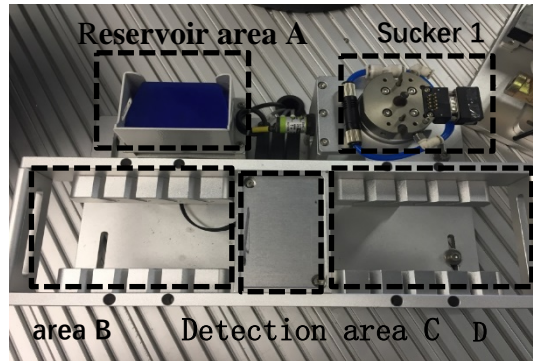


Figure. 5 solid stacking station

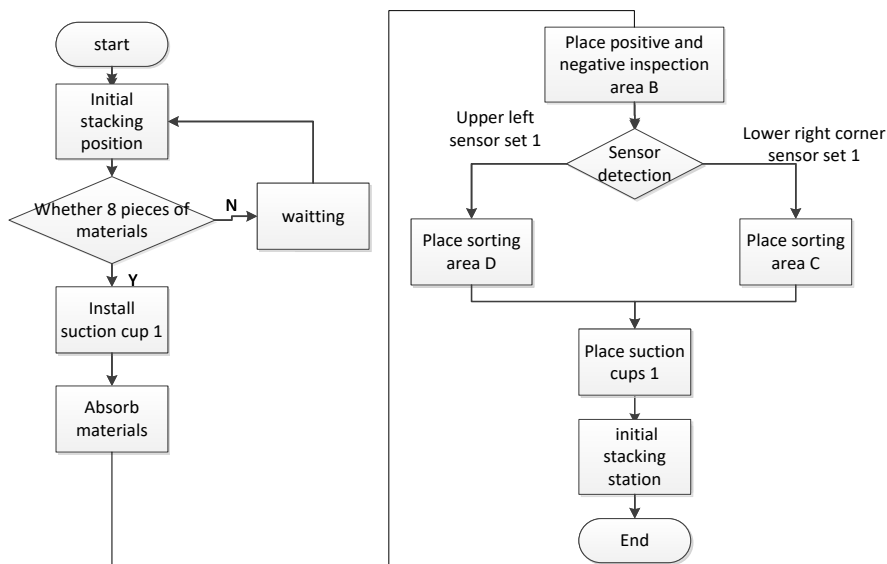


Figure. 6 work flow of stacking station

When the main function sends the task to the palletizing station, the robot system program initializes, and then the robot rotates to the initial position of the palletizing station. When 8 pieces of materials are detected in reservoir a, the robot installs suction cup 1, then the robot moves to reservoir a, absorbs the materials, and then places them in the positive and negative detection area C. According to the program judgment, when the trapezoid material is placed to cover the sensor at the upper left corner of the detection area, the material is placed in the sorting area D; when the trapezoid material is placed to cover the sensor at the lower right corner, the material

is placed in the sorting area B. The main applications are move J joint motion and move I linear motion. Considering the large number of points, reducing the workload of later debugging, the move off command is used. For example, when the robot sucks materials in reservoir area a, it only needs to take the coordinate point FJZ Ou Q when the top material suction cup is sucking, and the material thickness is measured as 5mm, which is offset downward in sequence. The program is as follows:

```
MoveL Offs(FJZ_Q,0,0,-(nboardpicknum-1)*5),v50,fine,tool1\WObj:=wobj0
```

In this way, as long as the point position FJZ, q is correct, the position of the remaining seven material suction cups is naturally accurate. The simulation effect of industrial robot application is shown in Figure 7.

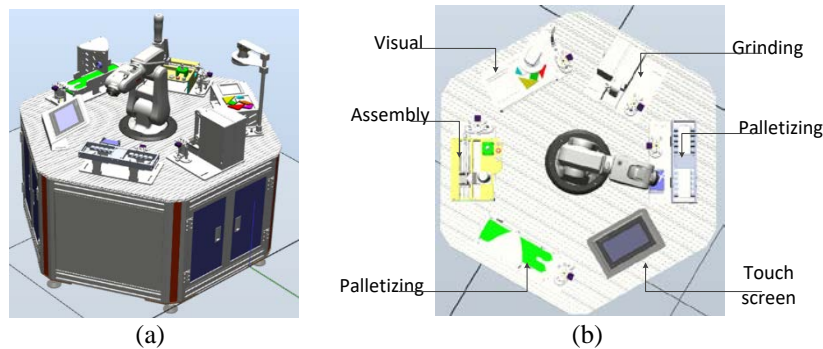


Figure. 7 simulation effect of industrial robot application

3. Platform simulation analysis

Through the teacher's demonstration in class and the discussion after class, students can complete the construction of the whole workstation on the simulation platform [9]. In the process of simulation, students can simulate the setting and simulate the action of industrial robots step by step, including adjusting the logical relationship of smart components, I / O connection, timing of each subprogram, point position, etc., completing the simulation test of each subprogram of stacking station, grinding station, vision station, assembly station and storage station one by one, and from the animation to the robot department in advance, conveniently and quickly. Modify it uniformly [10].

There are some uncontrollable situations in the real automatic production, such as the typical unexpected events such as pause, collision, sudden intrusion of personnel, etc. the improved program can realize the normal operation of the robot after restart and ensure the safety of production.

4. Conclusion

The simulation platform of the industrial robot application is based on the real platform, simulating the whole hexagonal table with five workstations. In the simulation software, an irb120 industrial robot, smart component design, I / O signal creation and offline programming are used to simulate the real robot application teaching platform.

Robot studio simulation software is helpful for students to quickly grasp the key points of robot teaching, improve students' innovative thinking ability, play a certain role in protecting students' personal safety, and reduce the damage of misoperation to school robot equipment. To sum up, the combination of virtual simulation and practical operation of teaching methods can effectively improve the teaching efficiency of the robot course for teachers and the learning effect of the knowledge related to industrial robots for students.

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