A Digital Twin Design Based on Robot Workstation

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Abstract

With the rapid development of intelligent manufacturing industry and the proposal of Made in China 2025 and Industry 4.0, Digital Twins DT has rapidly become a craze. Through the interaction between the physical object and the virtual model, the mapping is completed in the virtual simulation space, so as to reflect the actual operation process of the whole life cycle of the corresponding equipment workstation. The main structural content of this article is the research background and significance of digital twin technology, the current research status at home and abroad, the establishment of Solidworks physical models, the construction of PDPS (Process Designer&Process Simulate) workstations, and virtual simulation. Completed the construction of the robot seven color board assembly workstation, established a model of the assembly workstation, and combined this model with PDPS to simulate the workstation. Finally, the principle of connection communication and the achievement diagram were elaborated.

Keywords: Digital Twin, Robotic Assembly Workstation, Virtual simulation, PDPS

1. Introduction

"Made in China 2025" and "Industry 4.0" strategic plan proposed, so that intelligent manufacturing and artificial intelligence and a series of intelligent technologies and related development strategies continue to be proposed and implemented, therefore, digital twin technology has become a basic principle of intelligent manufacturing direction, and has received the general attention of all parties. Digital twin technology is the basis of intelligent manufacturing. It is gradually penetrating into manufacturing, medical care, urban management and other fields. The practical application of digital twin technology in control, perception, big data, artificial intelligence, modeling and other fields has also seen a centralized outbreak and growth [1].

As an advanced stage of digital development, digital twin will promote the integration of intelligent, information and digital development processes of integrated enterprises [2]. The development of digital twins has reached an unprecedented height, and now digital twins are not only an inevitable trend of national industrial development in the future, but also an important embodiment of the level of scientific and technological development.

The specific research content of this design:

First of all, the overall design and planning of the digital twin of the virtual simulation of the robot assembly workstation should be carried out. The following five aspects need to be studied and analyzed respectively:

(1) Understand and learn the overall structure and specific layout of the robot assembly workstation. Be fully prepared to build a layout in PDPS.

(2) Make and build models of ABB robot 1410 assembling workstation and other robot bases and other parts in SolidWorks 2019.

(3) Import all the models built in SolidWorks into the PDPS simulation software. Then build the workstation and write the robot motion instructions and paths. In the PDPS simulation software according to the actual layout of the assembly workstation.

(4) Carry out assembly simulation of all processes and route debugging in PDPS software to achieve the effect of workstation assembly and operation simulation.

(5) Communication steps and principles of virtual and real equipment of PDPS and robot assembly workstation.

2. General idea of system design

The system is mainly composed of off-line simulation module, twin module and auxiliary function module.

The overall process design flow chart of the robot assembly workstation system structure is shown in Fig. 1.

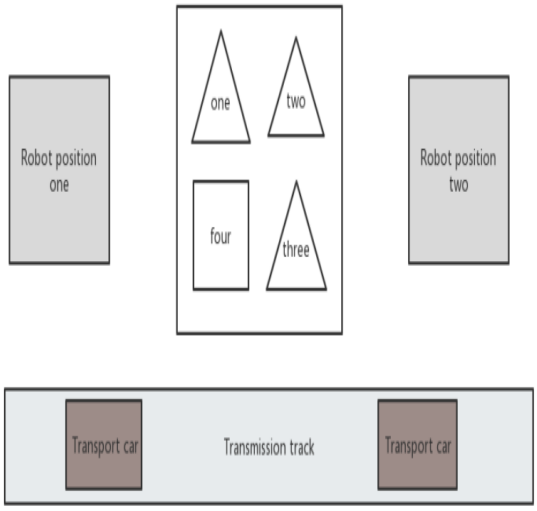

Fig.1.Process layout design flow chart of the system

The process mainly includes: the ABB1410 model industrial robot is placed in the No. 1 station and No. 2 station respectively, so that the robot carries out the handling and assembly work on the three seven-color panels and a cover plate on the storage platform in turn, and then transported to the No. 2 station robot operates the cover screw. After the screw is fixed, a set of processes is completed, and finally the object is transported to the finished product area by the transfer track.

3. Robot assembly workstation

The industrial robot used in the robot assembly workstation is an industrial robot specially designed for assembly. Compared with other industrial robots, the assembly robot has the advantages of strong flexibility, high precision, small working range, and can be used in combination with other operating systems. The main driving mode of the system is electric driving mode. The research scene of this paper should be carried out in the assembly of seven-color plates, and the advantages of industrial application are to improve production efficiency and reduce human capital.

For the model built above, the specific parameters are sorted out as follows. The model selection and size table of robot assembly workstation are shown in Table 1 below:

Table 1. Model selection and size table (Unit: mm)

No.	Name	Length	Width	Height
one	path	2400	575	800
two	Transport car	600	400	80
three	Bottom plate	200	200	30
four	Cover plate	200	200	20
five	Color palette one	150	150	20
six	Seven color palette number two	150	75√2	20
seven	Color palette number three	150	75√2	20
eight	Robot chassis	Radius 350	0	500
nine	Storage table	130	60	80

4. PDPS workstation construction and program design and simulation

The construction of the assembly workstation is mainly based on the layout of the robot training base to simulate the construction of the layout. Through the actual working principle and path of the robot, the coordinate position of the robot and the location of the material workpiece are first determined. Secondly, the trajectory and mode of movement of the robot are understood, and then the layout is carried out through the built model. As shown in the figure, the basic layout is composed of two ABB1410 robots, corresponding to station No. 1 and station No. 2 of the workstation. Station No. 1 is responsible for the assembly of 7 color board No. 1, 7 Color Board No. 2, 7 color Board No. 3 and the cover plate. It is transported to station No. 2 by the conveyor rail, and is responsible for fixing the screws on the four corners of the cover plate at station No. 2. Fig. 2 shows the preliminary model construction:

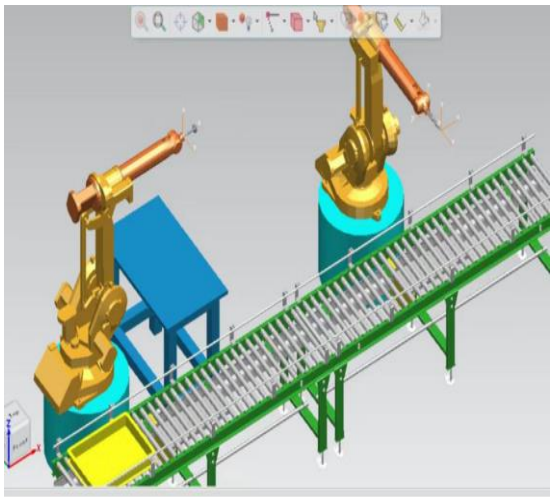

Fig. 2. Basic layout of robot assembly workstation

The robot assembly workstation is mainly composed of two stations, namely P10 station and P20 station. The robot at P10 station is mainly responsible for the handling and assembly of the 7-color board and the 7-color board cover plate, while the robot at P20 station is mainly responsible for the final assembly of the 7-color board by fixing the bottom plate and the 7-color board cover plate by screws at four corners.

The overall planning of the coordinate system of the robot assembly workstation, through which the coordinates of the robot and the robot base are connected, can be roughly divided into the establishment of the coordinate system of the seven-color plate and the cover plate, the coordinate system of the transport car and the chassis, and the motion coordinate system of the assembly robot OP10 station and the robot OP20 station. As shown in Fig. 3 below.

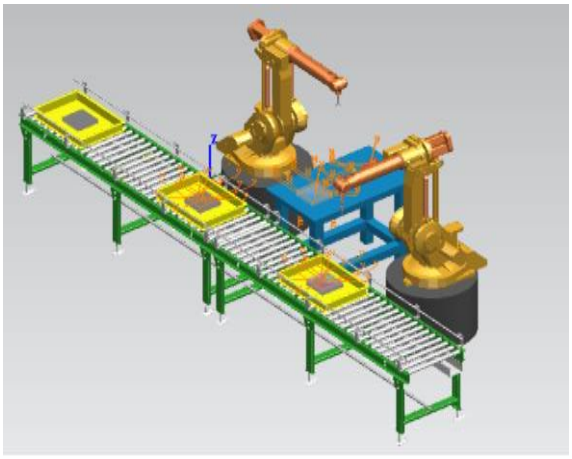

Fig.3. Coordinate diagram of robot and workstation

5. TIA+PLCSIM+NETTOPLCSIM+KEPServerEX virtual debugging

Open our robot assembly workstation in production line mode and click Add Zone, where the path and location can be observed [3]. Click on the motion simulation, and the robot station OP10 starts to carry and assemble the red triangle plate, yellow triangle plate, purple triangle plate and transparent cover plate successively. Meanwhile, the robot station OP20 also synchronously fixed the screws of the four stations of the cover plate. When the assembly is completed, sensor B receives the signal. The signal is received by NetToPLCsim. And the channel 4 signal shared by KEPServerEX, the PDPS workstation receives the virtual map of the OPC signal 1, and the conveyor begins to move. When the sensor A receives the position signal, which is the same as the signal B, the signal becomes 0, the conveyor belt stops moving, and the robot station OP10 and OP20 start handling and assembly. When the stop button is pressed, the signal is disconnected and the robot assembly workstation stops moving. The workstation of the robot is shown in Fig. 4.

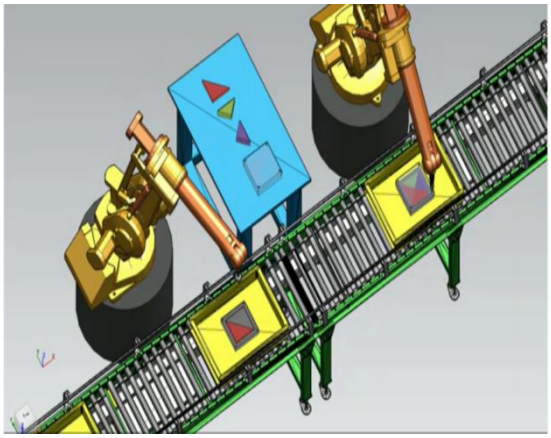

Fig.4. Robot motion diagram

6. Conclusion

In this paper, a simple control system can be realized through the construction and simulation of the basic model of PDPS software based on the working mode and basic method of robot assembly workstation. Do model construction, basic operation methods, path debugging. The virtual reality technology can realize human-computer interaction. The digital twin based on the robot assembly workstation mainly takes the assembly process of the seven-color panel as an example to simulate and simulate the actual robot assembly production line in the virtual space. The digital twin pursues the life cycle of the whole process, and this

design only adopts two stations of the robot assembly workstation for simulation and simulation. I hope it can provide some help for the research of relevant personnel.

References

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Authors Introduction

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He is a first-year master candidate in Tianjin University of Science and Technology, majoring in Intelligent multibody robot.