

Creation of Intelligent Manufacturing Training Platform

Qingwang Kong^{1,2,a}, Xiaojun Guo^{1,2,b}, Hui Li^{1,2}, Bin Sun^{1,2}

¹College of Mechanical Engineering, Tianjin University of Technology and Education, Tianjin, 300222, China;

²Digital Manufacturing Institute, Tianjin 300222, China.

^a352452568@qq.com, ^b18822111978@163.com

Abstract

In order to solve the problem of low utilization rate of equipment in practical training in colleges and universities, in response to "Made in China 2025", we vigorously developed the intelligent manufacturing industry, aiming to cultivate more intelligent manufacturing industry talents, and built a comprehensive training platform for intelligent manufacturing. The training platform is a combination of virtual and real, with CPS digital twin function, which integrates the programming and operation of industrial robots, CNC lathes, and CNC milling machines, PLC training, and digital management. This comprehensive training platform fits the concept of integration of industry and education in my country, optimizes teaching methods, and can promote the innovation of college courses and teaching.

Keywords

Intelligent manufacturing, Training platform, Colleges and universities.

1. Introduction

After the outbreak of the international financial crisis, developed countries began to adjust their development focus to the physical manufacturing industry and promulgated a series of national development strategies, such as the Advanced Manufacturing Partnership Program proposed by the United States in 2011, the Industry 4.0 strategy proposed by Germany in 2013, and 2015 The new robot strategy proposed by Japan, the digital European industrial plan proposed by the European Union in 2016, etc., the introduction of these policies will undoubtedly drive the world's industry to develop in the direction of intelligent manufacturing. The continuous innovation of computer technology and the continuous integration of software and hardware systems have undoubtedly become the catalyst for the development of the intelligent manufacturing industry. In Germany, two-thirds of the people will choose vocational education. The dual education system provides a steady stream of high-quality talents for the German manufacturing industry. The combination of schools and enterprises can be described as icing on the cake for the cultivation of skilled talents. In contrast to the development of domestic manufacturing, from the initial "Twelfth Five-Year Development Plan for the Intelligent Manufacturing Equipment Industry" to the official promulgation of "Made in China 2025", the country's policies for the development of the intelligent manufacturing industry have been gradually improved, which also shows that China The determination to become a manufacturing power. In terms of vocational education, although our country has been striving to cultivate skilled talents, the limitations of school teaching have not been able to create a good teaching system. Domestic companies also lack the enthusiasm for talent training. Therefore, it is necessary to build a vocational education system with Chinese characteristics. The construction of training bases in colleges and universities has become an important strategy for cultivating high-quality skilled

talents, but due to factors such as cost, most colleges and universities cannot achieve this strategic goal. In order to realize my country's dream of becoming a strong country in manufacturing as soon as possible, and to train more high-quality skilled personnel, the creation of an intelligent manufacturing training platform has proposed a feasible plan.

2. Creation of Intelligent Manufacturing Training Platform

With the advent of the intelligent era and the transformation and upgrading of the manufacturing industry, the society's demand for the machinery industry is not only satisfied with a single manufacturing, but also in order to improve factory production efficiency and human resource utilization. Robots, high-end CNC machine tools, and intelligent manufacturing The production line will be applied. The emergence of these advanced technologies will inevitably give birth to new jobs and content. Cultivating such new types of talents has become a key factor. The training of a new generation of young talents will rely more on various institutions of higher learning curriculum reform. At present, the problems of difficulty in teaching related to intelligent manufacturing, high prices of teaching equipment, insufficient teaching stations, and single teaching subjects in vocational colleges are also problems faced by most ordinary colleges.

2.1 Equipment introduction

The intelligent manufacturing training platform is composed of a real industrial robot control system, a real CNC machine tool control system, a programmable controller, a touch screen, a virtual scene system, an MES system, etc. It has the function of a CPS digital twin system. Each platform can provide 3 workstations for teaching, and the training scenarios cover more than 20 scenarios such as the Intelligent Manufacturing Competition of the Ministry of Human Resources and Social Security and the Ministry of Education, industrial robot training, and PLC training.

Intelligent manufacturing comprehensive training platform, for the intelligent manufacturing profession to carry out "Industrial Robot Operation and Programming", "Numerical Control Lathe Operation and Programming", "Numerical Control Milling Machine and Machining Center Operation and Programming", "Numerical Control System Parameter Debugging", "PLC Programming and Programming" Teaching, practical training, assessment and corresponding skill competition training for courses such as Application, Touch Screen Configuration Control, and Intelligent Manufacturing Comprehensive Commissioning. The platform composition is shown in Figure 1.



Figure 1: Intelligent manufacturing training platform

2.1.1 Hardware introduction:

① Scene running computer:

This equipment uses virtual equipment and scenes built by three-dimensional models. During the process, students can rotate, zoom in, zoom out, and translate the motion mechanism as a whole, or

zoom in part of the virtual mechanism to observe the work of the motion mechanism from any angle. Principle and design details. The main function of the computer is to set up the virtual equipment in the scene to communicate with the corresponding real control equipment, to run and watch the actions of the virtual scene equipment.

② MES running computer

The manufacturing execution system is a set of production information management system for the execution level of the manufacturing enterprise workshop, which can monitor the completion progress of the system during operation. The main function of this computer is to run the production process execution system of the equipment.

③ Portal (PLC programming) running computer

TIA Portal is a brand-new fully integrated automation software released by Siemens Industrial Automation Group. Through the programming of PLC, it realizes the signal connection between software and hardware, so as to achieve the function of equipment automation. The main function of this computer is to edit, add and modify the PLC in the application.

④ Kinco touch screen

Touch screens are also called man-machine interfaces in the automation industry. They are a dialogue window for information interaction between humans and computers. They can achieve hard and soft contact between humans and machines. This joint surface includes not only direct contact between points, lines and surfaces, but also remote The function space of distance information transmission and control makes the control of hardware equipment easier. This equipment is mainly for the study and design of Kinco HMIware configuration editing software.

⑤ Robot teach pendant

The teach pendant provides users with a data exchange interface and a friendly and reliable human-computer interaction interface, which can control the robot's actions, edit the execution files, provide variable settings and input and output, realize system settings, parameter settings and machine settings, Display alarm information and necessary operation prompts in time. This equipment can operate industrial robot movement, complete teaching programming, realize system setting, fault diagnosis, etc.

⑥ CNC car system and control panel

The operator can operate, program, debug, and set and modify the parameters of the CNC lathe (system) through it. It is mainly composed of display device, NC keyboard, machine tool control panel, status light, handheld unit, etc. The main function of this equipment is to understand the movement mode, running status, programming, debugging, setting and modification of the lathe parameters.

⑦ CNC milling system and control panel

Similar to the CNC lathe, the operation panel of the CNC milling machine is used to control the movement of the spindle, worktable and tool of the machine tool. The main function of this equipment is to understand the movement mode, running status, programming, debugging, setting and modification of the milling machine parameters.

2.1.2 Software and function introduction

The integrated intelligent manufacturing project includes 20 modules, which are mainly divided into: PLC training project; CNC lathe, CNC milling center programming and operation project; robot and intelligent production line training project; intelligent manufacturing competition (including the Ministry of Education and Human Resources and Social Security) Department) scene project.

1) PLC training project

The platform uses TIA portal v14 software to realize PLC learning. PLC training projects include seven-segment digital tube programming and operation, neon lamp programming and operation,

three-phase motor star-delta step-down start control, automatic drilling machine control programming and operation, Automatic tea dispenser control and programming, multiple liquid automatic mixing control programming and operation, and many other training projects, according to PLC programming and I/O point settings, click the corresponding compound switch to start operation. Can fully let students understand and learn PLC

2) Programming and operation items of CNC lathe and CNC milling machining center

The platform is equipped with real CNC lathes and CNC milling operation panels, and a virtual environment constructed by simulation software. Students can use the control panel to write programs, or they can use the DNC server to conduct centralized and intelligent network management of CNC equipment. All DNC programs can be programmed. It is completed in advance on the PC terminal and uploaded to the DNC server. The equipment operator can directly download the program required for the machine tool task from the server through the equipment CNC controller. After the program is processed, the on-site programming results can be sent back to the server in real time through the DNC network for comparison or archiving.

3) Robot and intelligent production line training project

The training projects include the following four:

1. Programming and operation of industrial robots
2. Intelligent turning debugging and operation
3. Intelligent milling debugging and operation
4. Debugging and operation of intelligent production line

Through programming and operating robots for automatic loading and unloading operations (real robot system and teach pendant + virtual scene), understand the intelligent manufacturing production line, and control the production line through editing and loading PLC, etc.



Figure 2 Smart production line debugging module

4) Smart Manufacturing Competition (including the Ministry of Education and the Ministry of Human Resources and Social Security) scenario projects

In order to stimulate students' interest in learning and improve the quality of teaching and scientific research, the intelligent manufacturing competition came into being. Scenario projects included in

the platform include: task training for the first intelligent manufacturing competition, task training for the second intelligent manufacturing competition, task training for the intelligent transformation and integration technology competition of manufacturing units of the Ministry of Education, and digital machine tool installation by the Ministry of Education. Harmonization and technical transformation competition job task training

5) Intelligent processing MES system

The MES system enables the intelligent manufacturing production line to be digitally displayed in front of people's self-developed MES system. The software system interface is clean, standardized and friendly; the software maintains user information and can define user role permissions; the software has a total of Divided into: scheduling management (manual arrangement, automatic arrangement, program management module), equipment management (machine tool collection data, robot data collection, silo management, monitoring function), measurement and tool compensation (tool compensation information collection, measurement Information collection, repair, quality traceability function), process design (automatically generate corresponding EBOM, PBOM and CNC machining process files according to the given DWG file, which can be modified and edited), production statistics (production data statistics, kanban), system settings (Network topology map setting, network verification log) Six modules, each module can be subdivided into small modules; the interface definition of MES and PLC is unified.

2.2 Equipment highlights

- 1) The scenario is in line with the National Intelligent Manufacturing Application Technology Skills Competition, the intelligent transformation and integration technology competition of manufacturing units, etc.
- 2) Connect with real industrial production lines.
- 3) The production line scene can be built independently.
- 4) Industrial and national MES system.
- 5) Industrial-grade online measurement verification.

3. Conclusion

- 1) The research and development of this platform summarizes the current problems in teaching and building equipment in domestic colleges and universities, and proposes special solutions for the existing teaching environment. In response to the "Made in China 2025" strategy, we will vigorously develop the intelligent manufacturing industry and actively explore practical and effective practical teaching models, aiming to contribute to the cultivation of talents in the intelligent manufacturing industry.
- 2) The creation of a comprehensive training platform for intelligent manufacturing has greatly improved the school land utilization rate. Adhering to the people-oriented thinking and the use of a virtual and real environment to build an environment, on the one hand, it improves the fault tolerance rate of students in operation, on the other hand, it solves the school's financial expenses and the personal safety of the operators, and not only allows students to fully understand the intelligence Create the charm of this industry, and students can discover the links between the subjects, instead of sticking to the learning of individual subjects. Looking at the smart manufacturing industry from a macro perspective can more stimulate students' interest in learning.

References

- [1] Ying Yulong, Chen Daner. The construction of simulation training platform for smart factories and the training of ERP talents[J]. Vocational Education Newsletter, 2017(21): 62-65.
- [2] Fang Zhaohui, Yu Heyang, Li Qi, Bai Ruifeng. The construction of virtual experimental teaching platform for intelligent manufacturing based on resource sharing[J]. Experimental Technology and Management, 2017, 34(04): 118-121.

- [3] Chen Xia, Wang Dahu, Wang Jingchong, Gao Huizheng. Research on the PLC teaching and training platform based on Unity3D[J]. Software Guide, 2016, 15(10): 111-115.
- [4] Li Jifang, Xu Yingjie, Bao Ping, Hu Tianlin, Lin Chun. Exploration on the construction of PLC virtual simulation training teaching platform[J]. Experimental Technology and Management, 2016, 33(07): 118-121.
- [5] Liang Jinrui. Design of simulation training platform for visualized industrial robot application system[D]. South China University of Technology, 2016.
- [6] Luo Wen. Enlightenment of German Industry 4.0 Strategy to my country's Industrial Transformation and Upgrade (Excerpt) [J]. Programmable Controller and Factory Automation, 2014(09): 36-39.
- [7] Duan Lei. Research on Numerical Control Teaching Based on Virtual Simulation System[J]. Machinery Management Development, 2013(02):169-171+173.