

Research on the Teaching Mode of Introducing Industrial Robot in Numerical Control Machining

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Abstract: Numerical control technology is the basis of modern manufacturing technology, and its wide application has caused great changes in the field of manufacturing industry. The level and popularity of numerical control technology has become an important symbol to measure the level of a country's manufacturing industry. With the transformation of China from a big manufacturing country to a powerful manufacturing country, the popularity of numerical control machine tools will gradually increase. At the same time, it will also stimulate the demand for numerical control talents. As a high-level, high-quality undergraduate teaching, it is imperative for the society to cultivate urgently needed numerical control talents. Starting from the teaching of numerical control machining specialty, this work studied the practical teaching system based on industrial robot, and determined the specific objectives, contents and methods. The industrial robot is fully applied to the numerical control machining process, thus comprehensively promoting the teaching development in colleges and universities.

1. Introduction

In recent years, digital control technology has been widely used in various fields of industrial production, especially in the machinery manufacturing industry. Ordinary machinery is gradually replaced by high-efficiency, high-precision, high-automation numerical control equipment. The demand for high-level applied talents in enterprises has increased significantly. Statistics show that the gap of numerical control professionals is about 600,000, and the demand for talents increases by 30% every year. However, the traditional teaching mode of numerical control technology in colleges and universities is mainly based on classroom teaching, supplemented by 6-8 class hours of numerical control principle and machining programming verification experiment [1]. This lacks the cultivation and training of students' engineering practice ability and innovation consciousness. The teaching effect is always unsatisfactory, and it is difficult to cultivate a group of high skilled talents who can master numerical control technology. The teaching system needs to be reformed and optimized.

2. The Importance of Introducing Industrial Robots into Numerical Control Machining

2.1. Teaching content

Robot is a kind of comprehensive intelligent system with the ability of perception, decision-making and execution, which integrates various interdisciplinary knowledge such as mechanics, electronics, sensing, control, etc. It is an ideal carrier for the innovation and practice of numerical control technology courses. Numerical control processing teaching mode based on industrial robot mainly teaches basic structure of industrial robot, kinematics and dynamics equation of robot, architecture of automatic control system, basic principle of sensor, etc. The purpose is to help students improve the application ability of mechatronics technology and lay a foundation for the subsequent career development. The course also builds training platform and simulation operating system on the basis of engineering mechanics, engineering drawing, mechanical design, manufacturing technology, motor drive, etc. It enables students to carry out

practical operation in the industrial robot environment, and truly realizes the combination of teaching knowledge and action practice, which is of vital significance for students' ability training and experience accumulation. It is an indispensable key part of numerical control machining teaching in the new era.

2.2. The role of industrial robot teaching

Based on the industrial robot system, the teaching reform of numerical control technology course is an application example, which has a certain guiding significance for the cultivation of numerical control machining applied talents. It is also a response to the "excellent engineer education and training plan" launched by the Ministry of Education in 2010.

(1) It is beneficial to stimulate interest in learning and cultivate practical ability. Generally, numerical control machine tools are bulky and inconvenient to carry, thus it is difficult for teachers to bring them into the classroom as teaching aids. They can only introduce them in the form of pictures or videos, or simply simulate the cutting process of numerical control machining through the numerical control machine tools simulation software. It is difficult for teachers to involve in the application of numerical control technology. Numerical control machine tool is a kind of numerical control equipment with high requirements for operator quality. In order to avoid the occurrence of safety accidents, strict operation rules are formulated. Even in the field teaching, students and numerical control machine tools will still have a sense of distance, and students lack of perceptual knowledge for numerical control technology. Therefore, students' sense of participation is not strong, and the teaching effect is poor [2]. There are many kinds of robots with different shapes, and some small robot products are brought into the classroom. Students can quickly shorten the distance with numerical control technology by touching, sensing, assembling and disassembling, and enhance their thirst for knowledge and practical power.

(2) A seamless transition of teaching content can be achieved. Numerical control machine tools and robots are basically the same in the content of numerical control technology. For example, interpolation principle is mainly used for the motion trajectory calculation of workpiece or cutter in numerical control machine tools, while it is mostly used for the motion trajectory calculation of manipulator and other executive parts in robot. There is no difference between them. The detection devices on numerical control machine tools mainly include photoelectric encoder, grating, laser ranging sensor, etc. These sensors are also widely used in robots. The servo drive devices used in numerical control machine tools, such as stepper motor, direct current servo motor, alternating current servo motor, etc., are also the main power components of robot. Numerical control device is the core of numerical control system, and the hardware architecture of robot and numerical control machine tool are very similar. In the industrial robots disassembly, maintenance and operation process, students can realize knowledge transfer, and better grasp the numerical control machine tools structure and numerical control machining process. Fundamentally, the students' practical effect can be improved.

3. The Teaching Mode of Introducing Industrial Robot in Numerical Control Machining

3.1. Introducing new ideas and standardizing curriculum content

According to the application case of industrial robot, students are helped to establish the analysis and design ability of typical machinery, and master the most basic skills of mechanical industry.

(1) It is necessary to introduce a real design case of adaptive mechanical assembly arm on a cam assembly line, and let students discuss in groups and adopt different design schemes. What kind of impact will it have on the performance of the final product, so that students can combine the technical parameters to design the scheme.

(2) Combined with engineering mechanics and mechanical design methods, the design and selection principles of various mechanical parts in the scheme should be explained. Also, students should be guided to design and optimize various parts and components in their own design scheme

according to the standard design method. This makes students have the ability to correctly select shaft, gear, bearing, pulley, hydraulic cylinder, control valve and other typical mechanical parts.

(3) The final examination is changed to submit robot design scheme and assembly drawings and reply. Students are required to submit robot assembly drawings that meet the drawing requirements. Through the large-scale robot comprehensive design process, students have strong ability to read and draw drawings. Under the limited teaching time, the teaching content of electronic control is shielded, and the mechanical background is highlighted. The practical robot application project is introduced, and the specific objectives and tasks are arranged in each class. Also, the project driven method is used to organize the teaching. The necessary mechanical vocational skill training is taken as the main line, and the theoretical knowledge is explained in combination with the training content. This enables students to understand the theory in the process of mastering skills, and achieve teaching objectives by guiding students to complete various tasks.

3.2. Introducing new methods and enhancing sensory awareness

In order to let students see the real object while explaining the theory, strengthen the perceptual knowledge, and avoid the empty teaching of pure theory, there are two solutions [3].

(1) It is necessary to build a special integrated classroom for teaching and learning courses, and purchase physical objects, so that students can see and feel the theory while learning. The scheme is effective. However, it costs a lot.

(2) By using the software virtual reality technology, it should build or download the database needed for teaching to carry out computer dynamic simulation. This scheme has less investment and is easy to implement. Therefore, a small number of class hours should be arranged to explain the application methods of dynamic simulation technology based on PRO/E or ADAM software in the process of industrial robot teaching. In the teaching process, students can truly see the work and operation of various shafting, gears and bearings in the robot mechanism they designed, and can feel the different motion effects produced by different robot structural parameters. The students' intuitive understanding of machinery is deepened and their interest in learning is improved.

3.3. Introducing new system and building practical platform

Industrial robots can be introduced into numerical control machining teaching to build a new training platform. GSK robots, Tek Bots robots, etc., are used to form a practical operating system, so that students can master the characteristics of numerical control machine tools in the process of practice, and reasonably use the professional knowledge of numerical control machining to solve practical problems. The flexible manufacturing system based on GSK robot has the ability of automatic loading and unloading and processing. It is composed of GSK robot, material rack and pneumatic numerical control lathe. Through a lot of modification, layout and programming, the automatic processing of numerical control lathe programming, loading and unloading and processing automation processing are realized, which effectively improves the work efficiency. After the completion of the system construction, teachers form a training system according to the above contents, including [4]:

(1) Training objectives. Through this study, students can master the intelligent numerical control machining technology, which is a new requirement for the cultivation of numerical control professional undergraduate talents, so that students have a deeper understanding for the industrial 4.0 intelligent numerical control teaching requirements. It is necessary to cultivate innovative consciousness and guide students to explore independently after class.

(2) Training content. Through the preliminary planning and construction and teaching program design, students are guided to use industrial robots to complete the learning of automatic loading and unloading and automatic processing in numerical control lathe programming and processing. During the training process, it is necessary to master the basic skills of coordination between GSK robot and numerical control lathe, and plan the loading and unloading trajectory of the robot, thus realizing the automatic loading and unloading operation and save manpower.

(3) Training evaluation. The evaluation subject of numerical control technology course is jointly undertaken by teaching teachers, experimental teachers and enterprise tutors. The evaluation system of innovative project teaching, including training process, training results, emotional attitude, participation, etc., is adopted to assess the students' training status from multiple perspectives.

4. Conclusion

Numerical control technology course is an important professional course of mechanical and electrical specialty. The traditional teaching method is not ideal. It is a positive attempt to adopt the new practical teaching method by taking the working robot as the teaching object, which has achieved good teaching effect. It also conforms to the engineering education system advocated by China in recent years, which takes "students as the main body, teachers as the leading, experimental project teaching as the main line, and training excellent engineers as the goal". The application experience of industrial robot teaching method in numerical control technology course will also offer an idea for numerical control machining practice teaching reform.

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