Exploration and practice of teaching reform of industrial robot course based on application ability training

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Abstract. Intelligent manufacturing is the main direction of the development of modern manufacturing, and robot technology is applied more and more widely, which puts forward higher requirements for the cultivation of robotics talents in Colleges and universities. As a pilot college transforming to an application-oriented college, we have carried out reform and exploration on the teaching content, teaching method and teaching mode of the course of industrial robot. We have adopted flexible and diverse teaching methods and step-by-step practical courses, which have effectively stimulated students' interest in learning, cultivated students' innovative practical ability and achieved good practical results.

1. Introduction
After the international financial crisis, many countries have a new understanding of the important role of manufacturing in promoting trade growth, improving research and development (R&D), improving innovation and promoting employment [1]. In the new round of industrial transformation revolution, Germany proposed "industry 4.0", the United States proposed "industrial Internet", and China promulgated "Made in China 2025"[2], which clearly proposed intelligent manufacturing as the main direction of the deep integration with information and industrialization. Industrial robot technology serves the intelligent innovation field of national equipment manufacturing industry [3]. In order to develop intelligent manufacturing, the development of robot technology is inevitable. Robots are more and more widely used. The society needs more and more talents who master robot application and maintenance technology[4].

Zhuhai College of Jilin University, as one of the first batch of "Guangdong ordinary undergraduate transformation Pilot Universities", shoulders the mission of innovation driving force of local economic and social development. Transition to a High Level Applied University is the focus of the thirteenth Five-Year Plan construction of Zhuhai College. The college is transforming from teaching oriented to social service oriented, from knowledge transmission oriented to innovation ability training, and from academic led to innovation application. The robot course offered by the college is a timely measure to meet the needs of robot application talents for industrial transformation and upgrading.

2. Current teaching situation of industrial robots
"Foundation of Industrial Robot" is the only course specially offered for a kind of equipment in colleges and universities. Robot is a typical mechatronics product. Robotics is an interdisciplinary subject involving machinery, electronics, computer, artificial intelligence, biology and other disciplines [5][6]. At present, the main problems existing in the teaching of robot course in colleges and universities include: more theories but less practice in the teaching process; more knowledge...
imparting but less ability training; the teaching content is aging and lagging, and the teaching focus is still on the mechanical arm [7][8], the analysis of the application background of robot in the new era is ignored; the new robot and the cutting-edge technology of robot are rarely involved; lack of the introduction of typical robot application cases; teaching mode is single, for example theoretical teaching is still based on derivation formula, which is boring and seriously affecting the enthusiasm of students; lack of experimental practice. All of these restrict the training of applied talents. We must change the education idea and training mode, reform in time and meet the needs of social development[9].

Professor Li Peigen, academician of the Chinese Academy of engineering, put forward the connotation of new quality of students' ability, new structure of specialty and curriculum, and new methods of education and Teaching [10]. The reform of industrial robot course based on innovation and application ability training needs to be implemented urgently. We must surpass the tradition from the aspects of teaching idea, teaching method, teaching content and teaching mode, keep up with the actual development of production and carry out targeted teaching reform.

Zhuhai College of Jilin University takes "theory - Virtual Simulation - Practice - Application" as the main line to carry out system planning and design reform on the course of Foundation of Industrial Robot. The overall planning of the teaching system is shown in Figure 1.

3. Optimization of teaching content

According to the knowledge base and learning ability of independent college students and the limited class hours of robot course in the training plan, the teaching objectives suitable for students' characteristics are formulated, and the content and focus of the courses are optimized. The objective is to enable students to build a knowledge framework of robot system within the limited class hours. Through the theoretical study in class, students will be familiar with the robot technology and its development overview, basically master the mechanism design of industrial robots, have an entry-level understanding of basic knowledge such as robot kinematics analysis and control system design, and master the knowledge framework of robot system; Through special lectures, the popularization of new robot technology and engineering application will be increased, and the development idea, engineering consciousness and cost consciousness will be inculcated for students, so as to train students to have certain industrial robot design and application ability. By assigning homework, students can consult a large number of robot related literatures after class, which will enhance their ability of literature review and induction, and make them fully understand the latest technology of robot.
Figure 1. Overall planning of robot course teaching system

4. Teaching method reform
Flexible and diversified teaching methods, such as theoretical introduction, video teaching, enlightening teaching; problem-based teaching; reverse classroom; virtual simulation, special lectures and other forms, are adopted to make the teaching of Foundation of Industrial Robot course intuitive, vivid, easy to understand, innovative and practical.

In this course, the engineering application examples of robots and advanced typical robots and their technologies are introduced to students in the form of video teaching, which will enlighten and inspire students' innovative thinking.
Enrich the teaching mode. Taking the existing robot equipment in the laboratory and the typical robot products in the market as teaching cases, combining with theoretical knowledge, and matching with appropriate video materials, students can have an intuitive and practical feeling on relevant concepts and technologies, which is convenient for students to understand, accept and master.

5. Multi-level step practical teaching design
Make full use of the existing resources, according to the different levels and interests of students, set up different levels and different types of step-by-step experiment and practice courses, including: basic cognitive experiment, typical institution experiment, comprehensive experiment, competitive experiment, research experiment, etc., to achieve the mutual promotion of "theory teaching, practice teaching and student competition". At the same time, through the robot association, guide the students who are interested in robots to improve their innovation and practice ability. By guiding and encouraging students to participate in robot related competitions, students' hands-on and innovation abilities can be enhanced.

6. Practical effect
Through rich step-by-step experimental practice courses, the students have a frame like grasp of robot system knowledge, a comprehensive understanding of the development and application of robots, the most important thing is that they have a strong interest in robots and stimulate the potential innovation of students. Some students choose the robot related topics in their graduation project, deeply understand and study the robot related technology, and make a lot of robot objects at their own expense. Some students even choose to work in robot related industries or even choose to start their own businesses with robot related products after graduation. Figure 2 shows some students' works.

Of course, there are still many problems to be explored in the teaching process, such as how to maximize the role of the equipment under the premise of limited experimental equipment, how to make students better understand and master the deeper theoretical knowledge of robot. The teaching reform of robot is a long-term work, which needs teachers to explore and innovate constantly.
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