Exploration on the Construction of Fundamentals of Robotics Innovative Course under the Background of New Engineering

Cheng Zhang[1, a] and Zhuo Zhang[2, b, *]

[1]Zhuhai College of Jilin University, Zhuhai, China

[2]Guangdong Polytechnic of Science and Technology, Zhuhai, China

[a]orangel221@163.com, [b]iammrlibira@126.com

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Abstract: With the rapid development of robotics, the significance of the course construction of robotics in the construction of new engineering courses in colleges and universities in China has become increasingly prominent. *Fundamentals of Robotics* is an interdisciplinary course, through which students' cognitive level and innovative practical ability of robotics can be cultivated. According to the characteristics of the robotics course, it studies and explores the teaching orientation, course content, implementation method, evaluation system and construction conditions and guarantee of robotics course in this paper, and puts forward the course construction plan from the perspective of improving the innovation ability, which provides some ideas for the robot course construction.

Introduction

In recent years, China has become one of the fastest growing countries in the robot industry. In May 2015, the State Council officially issued *Made in China 2025*. In the ten strategic areas, robot is the second strategic area, its importance is self-evident. In February 2017, the Ministry of Education issued the *Notice of the Department of Higher Education of the Ministry of Education on Research and Practice of New Projects*. Its main purpose is to carry out teaching methods and curriculum reform, and cultivate high-end application-oriented talents in a more effective way[1-3]. Robot has the natural attribute of high-tech content and multi-disciplinary integration. It is a good carrier to carry out a new round of engineering reform and improve the quality of teaching. Therefore, it is of great value and significance to carry out robot course construction and robot teaching task design in applied undergraduate colleges.

Current Situation and Development Trend of Robot Education

In May 2016, the Ministry of Industry and Information Technology, the National Development and Reform Commission and the Ministry of Finance jointly issued the *Development Plan of Robot Industry* (*2016-2020*), which proposed the overall development goal of China's robot industry during the 13th Five Year Plan period, that is, "To form a relatively complete robot industry system, significantly improve the technological innovation ability and international competitiveness, achieve the performance level of similar products in the world, make major breakthroughs in the quality level of key parts, and basically meet the market demand." Since then, the application and demand of robots in various industries have been expanding. At the same time, there are not enough high-level professionals engaged in robot system design and development, robot technology integration and robot system installation. In the *National Vocational College Skills Competition Implementation Plan* (*2017-2020*) released in September 2016, it was clearly proposed that the skills competition in the next 10 years should focus on the *Made in China 2025* strategy. Therefore, as a key development field of *Made in China 2025*, robot will become an increasingly important direction of applied undergraduate and vocational college curriculum education and personnel training.

At present, more and more science and engineering subjects in colleges and universities begin to offer robotics, robot control and other related courses for undergraduate and junior graduate students. As a science and engineering discipline of application-oriented universities, strengthening the teaching construction and reform of robotics foundation and other related courses is one of the most forward-looking and innovative development directions. Developing robot education and building related knowledge system has become the key to the development of application-oriented universities[4-5].

Analysis of Characteristics of Robotics Course Teaching

Robot technology integrates many advanced technologies such as mechanics, sensing, driving, control, computer software and hardware, and artificial intelligence. The course construction of robotics is naturally complex and comprehensive. The coupling of robot technology with other disciplines should be considered. At the same time, the practicality, innovation and relevance with robot related industries should be emphasized to ensure the role and significance of robot course construction.

Comprehensive and Interactive

Robot research is an interdisciplinary field. It is difficult for students to fully understand the robot's mechanical structure, motion control system, sensor system and the practice of practical engineering projects only through a single course. Facing to such a multi-disciplinary course, the traditional teaching mode can not be used to design and arrange teaching tasks. It is necessary to lay out the overall goal of talent training, consider the relevance between the front and back of the curriculum, and effectively set up an all-around discipline talent training system, so as not to become a "lonely island" of the curriculum.

Experimental and Practical

Robot course has a strong demand of experiment and practice. Only through the explanation of theoretical knowledge or the simulation of virtual technology, it is difficult for students to have an intuitive and comprehensive understanding of the robot system. In general, the investment of robot experimental equipment is relatively expensive. In order to ensure that students complete the necessary hands-on operation and debugging in the process of experiment and practice, it is necessary to coordinate the overall guarantee of the course equipment and teaching environment, so as to avoid the course "emphasizing theory and ignoring practice".

Industry and Innovation

At present, the robotics course and robotics discipline in China are just starting, and the staff engaged in the robotics industry are difficult to meet the post requirements in a short period of time, so the phenomenon of application-oriented talents vacancy has formed. Based on these, on the one hand, it is necessary to evaluate the promotion and supply function of the course construction to the current robot industry environment, on the other hand, it is also necessary to consider the medium and long-term construction and innovation development of the course, so as to form a solid and powerful course construction scheme and robot innovation talent reserve.

The Construction of Fundamentals of Robotics Innovative Course based on Innovative Thinking

Teaching Orientation of the Course

The course *Fundamentals of Robotics* (referred to as *the course*) is a task-driven professional course that integrates theory and practice. Through good connection with the pre and follow-up courses, with the method of "integration of theory and practice, learning and doing", and with the goal of "flexible learning and application of learning", students can start from the robot body and practical

application of engineering, cultivate their knowledge reserve and practical ability in the direction of robot, and further promote them to develop the habits of independent analysis and solution of scientific research problems. Taking robot and its related applications as the carrier, the course introduces the basic concepts of robot, explains the theoretical knowledge of robot related machinery, electronics, signal processing, control, etc., and enables students to have a preliminary grasp of robot system design, robot programming operation and system debugging by compiling robot motion control program, designing and debugging robot operation tasks Grip[6-7]. After graduation, they can be competent to lay a good foundation for robot work.

Content Design of the Course

The course content mainly includes the system composition and technical parameters of robot, mechanical system, power system, perception system and control system of robot, robot programming language and programming cases, etc[8-9].

The content of theoretical teaching includes: composition and technical parameters of robot system, types and composition of mechanical system and power system of robot, mathematical description method and mathematical model of robot, establishment and solution of forward and reverse kinematics equations of robot, establishment and solution of robot dynamics, characteristics and composition of robot control system and sensor system, and robot's programming language, basic debugging methods and application cases of robot in engineering. The experimental operation includes: select the robot model according to the use conditions, select the robot driver according to the application environment, select the robot sensor according to the use requirements, online programming and debugging methods of the robot, offline programming and debugging methods of the robot, understand the mechanical components of the robot human system, basic robot wiring, robot operating system and signal transmission lose.

Implementation Method of the Course

Adopt the teaching method of "teaching, learning and doing", and actively explore the comprehensive application of various teaching methods. Make full use of modern education technology, combine traditional classroom teaching, multimedia teaching and computer simulation technology. Absorb the advantages of various teaching methods, form a variety of teaching mode, make students more intuitive understanding of teaching content, stimulate students' interest in learning.

By using the project teaching method, students are introduced into the robot related projects carried out by teachers, and some design contents are assigned and guided to complete, so as to cultivate students' comprehensive thinking and hands-on ability, team spirit, and lay a necessary foundation for robot related work after graduation. A large number of cases are introduced into the classroom for teaching, so that students can master the robot related knowledge points, calculation design methods and programming operation methods. Teachers can use the way of video playing, add rich cases in the course, and pay attention to the relevance of hot topics in the field of scientific research and robots, by introducing hot topics to improve students' interest and cognition of robots.

Evaluation System of the Course

Due to the characteristics of the course, the evaluation and assessment need to pay attention to daily and practical. The general evaluation of the course includes three aspects: learning process, mid-term assessment and final examination. Among them, the learning process score accounts for 40%, which is evaluated according to the comprehensive performance of attendance, classroom performance, experimental performance, after-school work and innovation ability. The mid-term assessment results account for 20%, and it is recommended to conduct the practical assessment from the aspects of professional knowledge application, skill standard operation, comprehensive ability application, etc. The students randomly select the examination questions from the practical assessment question bank, carry out the practical operation on the assessment training platform according to the requirements,

and the teachers score according to the practical operation scoring standard after the examination. The final examination results account for 40%, and it is suggested to take the form of closed book written examination. The examination should be carried out from the aspects of mastering, understanding and using ability of professional knowledge. The types of questions can include concept questions (40%), calculation questions (30%) and programming questions (30%).

In addition, special attention should be paid to students' performance in robot innovation ability, such as participation in teachers' robot research projects, completion of students' autonomous robot practice projects and robot competition awards, etc., so as to encourage and promote students to carry out robot oriented scientific research and innovation activities, and give certain reward evaluation.

Construction Conditions and Guarantee of the Course

Training and Consolidation of Robot Teacher Team

The implementation of robot course needs the necessary reserve of innovative robot teachers. The colleges and universities should pay attention to the practical experience of existing professional teachers in enterprises, to form a mechanism for professional teachers to exercise in enterprises on a regular basis, and create a group of high skilled teachers with both professional qualifications of engineers or senior engineers and strong teaching ability. Through vertical or horizontal scientific research project development, technical services, vocational skills training and teachers' skills competition and other practical training ways to improve the practical ability of existing professional teachers, enhance the practical ability to solve engineering and technical problems, and promote the improvement of teachers' engineering quality. Pay attention to the introduction or secondment of engineers from the front line of the robot industry, and implement the robot course teaching according to the actual post requirements and talent training program, so as to realize the "zero distance contact" between college teaching and students' actual work content in the future.

Construction and Guarantee of Innovative Practice Environment

The practical condition construction investment of the robot course is large. It can make full use of the existing experiment and training equipment, and plan and improve gradually and step by step. The laboratory consists of robot basic principle laboratory, robot virtual simulation laboratory, robot programming and operation training room, robot application system integration laboratory, robot intelligent manufacturing comprehensive laboratory and robot innovation and creativity laboratory. In addition, The colleges and universities should pay special attention to the establishment of a joint training base between schools and enterprises, avoid the phenomenon of school teachers singing monologues, and promote the social forces outside the high wall of the school to participate in robot education together, especially the robot enterprises. Enterprises and universities jointly customize the talent training plan, combine the robot professional education with the industry demand, so that the robot training plan and teaching research plan developed have certain pertinence and practicability.

Summary

The reform of robot teaching mode in applied university is the requirement of industrialization and intelligence. The teaching characteristics of robotics are studied to meet the needs of the basic courses of robotics in the new engineering background in this paper. The implementation plan of *Fundamentals of Robotics* is planned, including course positioning, teaching content, teaching methods, course assessment, conditions and guarantee of course construction, which has certain reference significance for the construction of robot course.

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