

Developmental Situation and Strategy for Engineering Robot Education in China University

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Abstract

Robot education has an important role in cultivating engineering technologists in China university. Implementing the robot education, developing the educational function of the robot culture, exploring the educational value of intelligent robot, will propel the robot education innovation, promote the education reform and education modernization, improve the technology innovation and students' comprehensive practical ability. From two aspects, i.e., theoretical study and practical teaching, this paper discusses the current situation of engineering robot education in China universities. From the theoretical perspective, according to the connotation of the robot education and development situation, this work proposes the necessity and importance of the engineering robot education in China university. From the practical teaching, through investigating the characteristics of the engineering robot education, this paper analyzes the problems and shortcomings existing in our engineering robot education. Based on these, this work presents the reform measures and suggestions to enhance the engineering robot education in China university. Hopefully, it will benefit for cultivating our future engineering technologists.

Keywords: Robot education, engineering technology education, teaching robot, robotics courses.

1. Introduction

In February of 2007, Bill Gates published an article <Each home will have robots in the future> in <Global Science>. In this article, Gates forecasted that robot, together with the computer, would enter thousands of families and completely change human's life style. According to Bill Gates, the current development of robot industry is similar with the computer industry 30 years ago. From the simplest mechanical assembly devices on the production assembly line, to the surveillance robot used in the war, intelligent

mechanical arm used in micro-invasive surgery, and bionic robot designed in recently, robots are changing our work and life [1]. Therefore, we can forecast that our future life will be filled with the intelligent robots, personal computer used now will be drastically substituted by personal robot.

With the development of technology progress and social development, human has clearly realized that future internal is cell phone and robot, not the computer, and transform from the personal computer to the personal robot is irreversible. At the same time, with the rapid progress of robot technology and its applications, university engineering education puts forward new demands for the robot education [2]. Robot education mainly includes two aspects, one hand is studying the robot related theory and technology in narrow sense, the other hand, in broader sense, is using the robot to optimize the teaching effect and promote the students' study efficiency, aside from studying the robot related theory and techniques. Experts believe that till the middle of 21st century, human will enter the intelligent era represented by the intelligent robots [3,4]. Nowadays, the engineering robot education in our country starts late and develops lag, so executing the robot education in universities, especially in the engineering universities in China, is an urgent problem.

2. Importance and necessity of engineering robot education

Importance and necessity of engineering robot education in China universities lie in the following three aspects.

2.1 Cultivating students' engineering thinking

The main teaching content of robot education in China engineering universities is the robot's basic theory and construction. Concretely, it includes four aspects: robot structure and design, intelligent robot programming, robot

hardware assembly, robot system debugging [5]. In these teaching practices, robot structure and design demand the students innovative and are able to design the simple robot, and design is the most essential embody of the engineering thinking. As an important process to endow soul to a robot, robot programming not only demands the students rigorous logic thinking ability, but also systematically check their theoretical knowledge [6]. So the programming can train students' engineering thinking to the maximum extent.

Robot education needs acute observation and right thinking. Engineering thinking cultivating can train students' logic thinking ability, and make them to correctly deal with the logic relation between image and abstract, concept and reasoning, and so on.

2.2 Foresight and fusion of the robot education

(1) Cutting-edge academic research value

In the new era with economic globalization and knowledge economic rapid progress, robot education can cultivate high level engineering technology personnel and strengthen the innovative technology personnel. It provides a new mode to train the high level engineering technology personnel in information technology domain [7]. On the basis of cultivating information practical and innovative personnel, it can accelerate the further development and perfect the relate theory, and obtain abundant theory results and realize their academic value. At the same time, under the guiding of the multi subject technology theory, the robot education can promote the students' study interest, direct their thinking, advance the students' understanding and achieving the theory, and then it can provide beneficial help in cultivating the innovative personnel and further develop the academic theory.

(2) Cross and fusion of inter-discipline

Robot education involves basis of computer, communication technology, sensor technology, emotion computation, mechanics and automation, etc, thus it can greatly drive the technology fusion and development. Robot education and robot product development can realize compatibility of several complex technologies, promote the artificial intelligence to a higher level, and emerge the magic of the technology changing the world [8]. In addition, robot education can strengthen the core competition of China high level engineering technical personnel in information technology domain, lead the new product and new technology and system's innovation and operation, grasp the speaking right in industry technology innovation and development.

(3) Improve the science quality and practical ability

Robot education mainly applies course teaching and robot competition which reflect Dewey's teaching idea - "study from practice", and further develop to practice from study. In the study procedure, it emphasizes the combination of the brain and hands and is helpful to change the traditional teaching mode, and provides a massy base for the students' life long study. Moreover, robot education provides a new platform for the basic education reform. Robot education contains the basis of computer application, program design, embedded systems, interface technology, sensor technology, artificial intelligence, electrical engineering, etc, and it has special effect on cultivating the application ability and practical ability of the engineering personnel.

2.3 Practicability of robot education

Practicability of robot education mainly embodies in robot teaching practice activities, such as the China robot open competition. Robot open competition can make more students to grasp the robot theory and technology, popularize modern intelligence science knowledge, and cultivate more technical personnel for our national future robot industry [9]. Robot competition plays a key role in advancing the progress of robot technology and fusing the relative subjects. Researchers of the robot competition use various technologies to obtain better solutions which in return promote the development of each technology. Enough technology preparation before students talking part in studying, developing and designing the robots, technical supports from technicians and professional teachers, and communications among the students, etc, are the practical problems needed to face in robot education. During the competition, students not only learn the robot technology, but also enhance their self-confidence, promote the communication and team cooperation, improve their practical operation ability, which is one of the goals that the robot education hopes to achieve [10].

Aside from the important research value, the most important thing of the practicability of robot education is combining the theory and practice, to enhance the students' operation ability, innovation ability, cooperation ability and comprehensive ability.

3. Characteristics of robot education in China university

3.1 Activity organization mode

There are three main activity organization modes in robot education in China universities. First, opening the technology courses, just like the robot education in abroad universities, no matter in China universities or abroad universities, opening the relevant courses about robot is the core to develop the robot education. Second, robot extracurricular activities, the robot extracurricular activities in China universities include robot course experiments and different levels of the robot competitions. Third, recently, partial China universities with better conditions began to use robot technology as an assistant tool to assist the teaching of other courses. As a research tool, the teaching robot is applied to cultivate the students' innovative ability. In China universities, teaching robot is classified as the special robot education mode.

3.2 Course content

There is no uniform set national course in China engineering universities, and each university chooses teaching material according to its own course. Partial China universities adopt their own teaching materials, for example, Central South University set up its own robot boutique course, teaching robot material used by the students of school of information science and engineering in Northeastern University is published by its own press. Each university arranges its own teaching plan about the robot education according to its actual situation, and executes its autonomous course decision. China universities have great autonomy in how to execute the robot course teaching and how to enrich the robot course system. In addition, a sea of robot associations have proposed many course reform plans which are suitable to the robot education development and popularization in China universities, and presented specific and concrete guiding suggestions.

3.3 Teaching manner

There are three main teaching manners in China universities engineering robot education. First, class discussion. In early time of developing the robot education in China universities, since the teachers lack the systematic robot technology knowledge, teachers also study the course simultaneously during the teaching. In early time, just like the traditional teaching manner, university robot education mainly adopts the way - teacher teaching and students listening. This manner lacks the communication between the teacher and the students, and students are often dissociative out of the teaching environment. Recently, with the development and popularization of the robot education, robot education is carried out after the students have grasped the basic theory knowledge, so the class discussion become the main teaching manner which

promotes the communication between the teacher and students, and communication among the students.

Second, spot teaching becomes a main teaching way. Much robot knowledge are very abstract, it is difficult to build a model only through teaching and discussion. In order to let the students grasp and understand the robot relative knowledge, such as kinematics, mechanism, etc, many universities transfer partial class to the robot laboratory, taking the real robot as the teaching example, teachers demo and spot teach the robot knowledge, e.g., robot structure, framework, engineering modeling, kinematics and dynamics, etc.

Third, adding special work paper discussion to the teaching manner. Generally, universities which execute the robot education have the special work paper discussion, which is initially developed by Beihang University in graduates' education. Aim of the special work paper is to expand the specialized knowledge of the students, dynamically integrate the robot knowledge learned in the classes and personal future research direction. Students consult the topic selection of the special work paper with their tutors, and the paper format is in accordance with that of the journal, and the students are required to analyze the special content related with the courses they studies.

3.4 Evaluating Manner

In China universities, evaluating manner of robot course, i.e., the total score is composed of two parts: process evaluating and the final evaluating. The former is evaluated through the finishing degree of the students experiments and design projects, while the later is evaluated by the students' substantial achievements. Robot education requires that the students' self introspection should be focused. Diversified evaluating manners adopted by China universities are helpful to completely indicate the theory and technology grasped by the students during the robot courses, especially the flexible application of these knowledge.

4. Existing problems of robot education in China universities

4.1 Lack of a complete set of teaching material

Since the robot education in China universities is still in starting phase, teachers usually lack the necessary teaching cases and teaching courseware in practical teaching. Moreover, robot education in China universities are short of the teaching reference, and each engineering university

has to design teaching and editing the teaching material by itself, which results in the robot education without the necessary supporting and guiding in certain degree.

4.2 Teacher deficiency

Due to slow progress of robot industry, China has not cultivated enough robot professional technical personnel, especially the robot personnel with multi-disciplines. Nowadays, in many China universities, teachers who teach the robot have not achieved systematic robot education, which hinders the rapid progress of robot education in China. So it requires that the professional development of the robot education, needs not only to promote the social understanding of the robot education, but also need the university to provide a good environment for the robot education.

4.3 Lacking the special robot activity field

In robot education, many teachers regard that the largest problem in robot education is lacking of the activity field. In recent years, with the fast increasing of the student number, more and more rooms are occupied as other functional classrooms. The robot activity field is usually the robot lab, and the limited lab space has become one of the barriers in robot education.

4.4 Unclear education goal of the relevant activity

Robot competition is a main component of the robot education. Due to influence of the commercial factor, education goal of the robot competition is not very clear. Some robot competition contents are totally commercialized, running according to the requirements of the investors. Moreover, competition content is old and lacking of innovation, without technology content, so the students' capability can not improve in the competition. So the commercial robot competition can not get the goal of popularizing the robot education.

5. Measures to promote the engineering robot education in China University

5.1 Define the cultivating goal of engineering technologist

Engineering is a practical process to transform the nature through applying the science principle and technology. From the perspective of robot producing, it has clear engineering characteristics. Education key point of high engineering is to solve the problems met in executing the

engineering. These problems are usually un-definite. In China universities, high engineering enlighten education is developed to cultivate the engineering technology idea of the students, with the robot as the education carrier. Engineering education will help the students to enhance their innovative ability, engineering practical ability and the ability to deal with the emergent problems.

Engineering idea is one of the most important and most essential qualities not only for the engineering technical personnel, but also the basic quality for each technical personnel. Because the engineering idea not only plays a part in the engineering project, but also asks the students to independently think various problems from the perspective of engineering thinking, seize the main contradiction of unpredictable practical problems, have the science quality of solving the practical problems appropriately and simply, and have the ability to self-study and self-perfect combining with the practices.

5.2 Rationalize the course content and teaching execution

In university computer basis education, how to transfer the current teaching manner, core with the personal computer, to new teaching manner, core with the personal robot, reform of engineering basis course is the main method. In the course reform and development, the following four suggestions should be emphasized.

(1) Course set reform

In China, there are not many universities opening the robot course for the undergraduate, and most courses set are the traditional basic ones. In addition, only partial universities open the robot introduction for the undergraduate which make the students without a general understanding of the robot in undergraduate phase. In china universities, robot course is mainly opened at the first semester of the master, and the course opened is high robotics. Since many students have no enough knowledge preparation and go into a deeper study directly, so they are easy to disjoint in constructing the knowledge structure. In our universities' course set, robot course should be advanced to undergraduate stage from the current graduate stage. In undergraduate stage, course set should be various, e.g., compulsory, major optional or university optional, etc. Furthermore, course set should be adjusted actively according to the students' feedback. Robot course should emphasize the frontier progress and latest results in robot technology.

(2) Promote the position of the robot course

In abroad universities, basically, time rate of the robot experiment and class teaching is high, while in China universities, robot experiment time is relatively short, even more than half universities has not opened the robot experiment. Due to the resource limitation, some national universities has not set the robot course assessment, and the robot course has become a general course activity. Establishing appropriate course content and teaching scheme, have become a good way to increase the teaching quality and students studying quality. Appropriate course content and teaching scheme can make the students to systematically and deeply study the robot knowledge under the condition of meeting their cognition level. Robot knowledge has strong practical utility, so it can lay massy foundation of students future engineering practice and innovative research results in their research procedure. Robot course position promotion can make it to be a necessary component of the university courses and break away from the general extracurricular activity.

(3) Course plan reform

In the usual robot course content, there are some difficult compulsory courses, such as the courses related with the robot kinematics and dynamics, which are difficulties and emphasis of the robot teaching. If the students have no relative knowledge basis or are not engaged in the robot design work, it is very difficult for them to grasp the robotics. So on the basis of the compulsory courses, teaching plan needs to add some assistant optional courses, research course and comprehensive practical courses, such as simple robot arm manufacturing. It includes three modes: spring-back machine and its control program, spring-back machine and control circuits, motors and transmission mechanics, which integrate the techniques of mechanics, circuit and control, and the application of information technology, is a new teaching platform built on the computer technology. On the basis of the relative optional courses, it is easy for the students to understand the robot kinematics and dynamics. Therefore, adding some auxiliary optional courses, research courses or comprehensive practical courses in the teaching plan can make the students not only to better grasp the knowledge in the compulsory courses, but also have a basis and cognition on other relative technology and theory, and widen their study breadth.

(4) Enlighten course positioning

Characteristic of robot involving multi-discipline determines the multi-element course positioning of the robot education. From the viewpoint of course design, development and management, courses that the robot

education executes are national course and university courses corresponding to each university. Its main aim is to demonstrate the university's teaching purpose and specialty. University course positioning should depend on the university actual situation, rely on its teaching basis and development direction, develop its superiority and specialty. Aside from these, course positioning should optimize and utilize current course resource, guarantee the teaching plan to implement fluently, ensure to provide necessary personnel, material resource, financial support, supervise and urge course progress and check the course quality. Therefore, opening of the university course is a forceful guarantee for the development of the robot education.

5.3 Strengthen the teachers team cultivating and constructing

Robot culture is a new culture style which integrates the science spirit and humanity spirit, produced during the human's dreaming and pursuing the robot. Innovation is essence of the robot culture. Robot campus culture construction, with the robot competition as the carrier, can promote the scientific spirit and scientific ethics, and form a harmony and unified entirety combining with the universities' education thought, teaching environment, university specialty, etc. Introducing the robot to the campus can carry out a great many novel activities, for example, constructing the robot campus website can direct the students far away from the network addiction through positive guide, transform the students' interest to research or study on the robot. Development of the campus technology activity can choose the robot as the activity theme, which can make the robot to be the common interest among the students and teachers. So, robot campus culture construction can provide massy interest foundation for the robot activity in university campus.

Moreover, strengthening the teacher team, the following aspects should also be focused, e.g., updating the teachers' robot education and teaching idea, changing the traditional inculcating way of teaching, advocating students autonomous study, cultivating students innovation spirit, guiding the students tactile learning, providing more engineering practical chances for the students, asking the students to organic integration the professional knowledge and the ability during the practices, forming the robot education teaching approaches conforming to the university's teaching specialty.

5.4 Expand university robot education field

In China universities, expanding the engineering robot education not only includes to introduce several industrial

robot or make the students to grasp the simple robot modeling, but also to develop and manufacture the teaching robot with distinct characteristic and practical utility. Developing and assembling the teaching robot can make the students to understand and master the roles of the general sensors and the power plant, understand and realize that program is the soul for robot running, understand the robot work principle, learn scientific and efficient thinking manner through programming the teaching robot, promote students' logic thinking and design ability, enhance the students' ability in planning and resolving the problems, cultivating the students' operational ability, communication ability and innovation ability.

5.5 Cooperate with enterprise to develop the teaching and research

Personnel communication between universities and enterprises play a important role in developing our university robot education. University can provide scheme to the enterprise according to its demand, and also provide suggestion for the enterprise to research, design and develop the appropriate teaching robot. At the same time, professional teacher can communicate with the personnel from the enterprise to summarize the teaching experience and problems emerged in the robot education, understand the study requirements of related technical personnel, carry out new exploration and reform in cultivating the science quality of the engineering technical personnel and promoting students' practical ability, realize win-win between teaching effect and enterprise revenue.

Through intimate cooperation between universities and enterprises, robot education can exert greater and more active role in education, security, military, information industry, equipment manufacturing industry and culture industry, realize the technology results to be transformed into commercial applications, create the win-win situation between university academic value and the enterprise economic value, exploit new development mode integrating the production, study and research.

6. Conclusions

Robot education plays an important role in our high education and economic domain. It not only creates a new path to explore cultivating engineering technique personnel, promote the quality and capacity of our higher level engineering technique personnel, but also has strategic influence in building the innovative country, pushing forward the leap-type development of our manufacturing, communication and other related

industries, promoting the labor productivity, enhancing the products' technique and quality level, realizing the economic structure transformation. So we must greatly develop the robot education in our universities. This work summarizes the characteristics of the robot education in China universities, and then analyzes the existing problems, finally it presents the corresponding counter measures to cope with these problems.

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