

# Exploration and Practice of Mechanical and Electrical Practical Teaching System Mixed with Robot Application Technology

\*Ping Liu<sup>a</sup> and Yiman Z'hao<sup>b</sup>

<sup>a</sup>liuping@san'dau.edu.cn, <sup>b</sup>ymzhao@sandau.edu.cn

college of Engineering, Shanghai Sandau University, Shanghai 201209, China  
No. 2727 Jinhai Road, Pudong New Area, Shanghai, China

**Abstract.** Experimental practice is essential for undergraduate engineering profession, especially for mechanical and electrical profession. Robot technology is the development direction of contemporary new engineering and has broad application prospects. Therefore, it is necessary for mechanical and electrical profession to build practical teaching system and mixed with robot application technology into it. Through research, exploration and practice, this paper holds that a mechanical and electrical practical teaching system mixed with robot application technology can be constructed by modular method. This system, on the basis of the effective classic mechanical and electrical practice curriculum, adds the robot application technology actually used by society and enterprises in the experimental. This system can unite the training of classical mechanical and electrical talents with the training of modern robot application talents. The practice in mechanical and electronic engineering profession has proved that it has been welcomed by students and enterprises.

**Keywords:** Robot application teaching, Mechanical and electrical experiment practice teaching, Teaching curriculum system

## 1 Introduction

Mechanical and electrical technology is the core of equipment manufacturing industry, so it is very important to build a practical teaching system for mechanical and electrical profession, because it is impossible to cultivate qualified mechanical and electrical talents without corresponding experimental practice conditions, reasonable experimental practice system and practical experimental practice teaching measures for engineering majors, especially mechanical and electrical majors.

In order to the trend of the development of science and technology in the world, the Ministry of Education advocates that the engineering profession should vigorously introduce the upgrading of the connotation of new engineering. One of the important contents of the new engineering is robot engineering. According to the development plan of the Ministry of Industry and Information Technology, about 200,000 industrial robot application practitioners are needed. This means that in the future, an average of more than 30,000 industrial robot application talents need to be cultivated every year. The knowledge and ability of robot

application have become the necessary knowledge and ability of contemporary mechanical and electrical students.

All applied colleges and universities attach great importance to the construction of experimental practice teaching system including robots. For example, literature<sup>[1]</sup> aiming at the training needs of contemporary college students comprehensive quality, adopts the concept of engineering education in the robot practice teaching process and cultivates application-oriented talents with solid theoretical foundation and practical ability through science and technology competition, literature<sup>[2]</sup> proposes to integrate the concept of OBE into the practical teaching curriculum system of robot engineering, literature<sup>[3]</sup> pointed out that virtual simulation technology is integrated into the teaching of robot practice courses in order to change the disconnection between the teaching and application of traditional robot practice courses. Literature<sup>[4]</sup> mentioned that in order to meet the training requirements of engineering ability in engineering education certification standards, a structural model of engineering ability training for mechanical and electronic engineering undergraduates was constructed. Literature<sup>[5]</sup> combined with the reform of applied technology colleges and universities, discusses the reform of practical courses for mechanical and electronic engineering profession in colleges and universities Literature<sup>[6]</sup> takes mechanical and electronic engineering as an example to discuss the research and practice of training new engineering talents for local economic and social development. Literature<sup>[7]</sup> conducted a study on the construction of robot teaching platform for mechanical and electronic engineering profession in universities in view of the ability needs of new manufacturing talents, literature<sup>[8]</sup> in the IEEE International Conference on Education Work, is pointed out that the task of mechanical engineering major in higher vocational schools is to solve the problem of insufficient training of engineering practical ability in teaching plans and courses. Literature<sup>[9]</sup> pointed out at the ASEE Annual Expo that students majoring in mechanical and electrical engineering should have practical knowledge and ability of energy creation, use and consumption. Literature<sup>[10]</sup> pointed out in order to improve the mechanical and electrical ability of students in mechanical engineering in the author introduced the robot project in the course of intensive practice in engineering Training. Literature<sup>[11]</sup> take the teaching direction of industrial robots in the field of mechanical electronics as an example. Literature<sup>[12]</sup> pointed out that a major challenge currently facing departmental lecturing staff and programme coordinators is that of the design of balanced programmes in Control and Automation Systems, to adequately reflect the importance of both streams. Literature<sup>[13]</sup> pointed out that mechatronics is an interdisciplinary engineering field that involves knowledge across mechanical, electrical, and software engineering. In general, undergraduate engineering programs teach.

It can be seen from the existing literature<sup>[1-13]</sup> that it is very important to establish the experimental practice teaching system of mechanical and electrical profession, and it is imperative to mix the robot application technology into the experimental practice teaching system of applied undergraduate mechanical and electrical profession. Based on the above reasons, this paper explores the experimental practice teaching system of mechanical and electrical profession mixed robot application, which not only conforms to the national training standards for classical mechanical and electrical talent training, but also blend the training of robot application knowledge and ability required for actual production in the whole system (including professional basic courses, professional theoretical courses and professional experimental practice teaching links).

## **2 Construction of mechanical and electrical professional practice teaching system mixed with robot application technology**

### **2.1 The way of mixing robot into the practical teaching system of mechanical and electrical specialty**

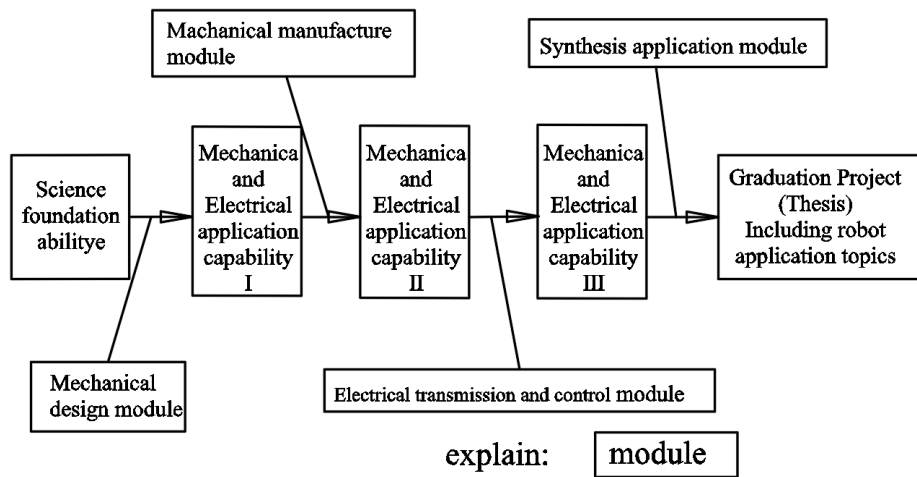
Robot device is the most typical and complex device of mechanical and electronic integration. Robot technology involves manipulator, mechanism kinematics and dynamics, electrical drive, sensor, path and trajectory planning, visual recognition, robot language and offline programming, control system, artificial intelligence, etc. Obviously, it is impossible for students to master these technologies comprehensively. However, it can enable mechanical and electrical students to master robot apply technology from the perspective of sufficient social production. In fact, mechanical and electrical professional knowledge is more comprehensively related to the basis of robot application, so it is both necessary and feasible for applied mechanical and electrical profession to integrate robot application technology into mechanical and electrical courses, and it is completely possible for students to master robot technology from the application level. For example:

- mix the knowledge of robot body motion and dynamics into the practical course of mechanical principles.
- The drawing method of robot structure and the selection method of reducer are mixed with the practical links of engineering drawing, computer-aided design and mechanical design courses.
- In the practical links of sensor and test technology courses, the principle analysis and selection method of robot sensing are mixed.
- In the mechanical and electronic transmission control, hydraulic and pneumatic transmission control and other courses mixed with the robot drive mode, choose the appropriate motor, cylinder and the corresponding control mode
- Add robot technology courses, which mainly involve robot classification, basic composition, mechanical structure, common body structure, common sensors (including vision and force control sensing principles, etc.) and common control methods.
- Increase the practical teaching of industrial robot application courses, which mainly involves the application of the most typical industrial robots used in industrial enterprises, the structural analysis of typical industrial robots, the offline programming methods of industrial robots, and various application methods of industrial robots.
- In the teaching of comprehensive practice courses, practical links such as robot innovation production and path planning are blended, and students are actively guided to participate in robot production and competition projects.
- In the graduation design (thesis) of the Mechanical and electrical major, students are encouraged to choose topics related to the comprehensive analysis and design of robots, and provide experimental and practical support.

In short, mechanical and electrical majors can fully mix robot application technology in the curriculum practice system.

## 2.2 Practical teaching practical system of mechanical and electrical specialty mixed with robot application technology

According to the national teaching standards for mechanical and electrical profession (requirements that mechanical and electrical profession must meet) and the idea blending robot application technology (requirements for mechanical and electrical profession development), a modular mechanical and electronic engineering application-oriented undergraduate practice teaching system can be designed to promote mechanical and electrical profession application technology ability training. Its structure is shown in Figure 1 below.



**Figure 1.** Structure diagram of practical teaching system of mechanical and electrical profession mixed with robot application technology

This application-oriented undergraduate practical teaching system for mechanical and electronic engineering profession not only meets the national requirements for the practical ability of mechanical and electrical profession, but also mixes the application technology ability of robots. The practical teaching system designed is composed of four practical ability modules and graduation design (thesis) ability training, which gradually promote the cultivation of students mechanical and electrical application ability. It is composed of mechanical design practice ability training module, mechanical manufacturing practice ability training module, Electrical transmission and control practice ability training module, synthesis application ability module including robot technology and graduation project (thesis) including robot application topic.

### **3 Implementation of mechanical and electrical professional practice teaching system mixed with robot application technology**

#### **3.1 The implementation of practical teaching system (See Figure 1)**

The following takes the mechanical and electronic engineering profession of engineering as an example to explain the implementation of the practical teaching system of mechanical and electrical profession blended in robot application technology. The practical teaching system can be implemented using the following modular capacity cultivation methods, which are gradually promoted, namely:

##### **(1) Mechanical design practice ability training module**

The mechanical design ability training module is composed of engineering drawing and CAD, engineering measurement and drawing, engineering mechanics machine and mechanism theory, mechanical design, computer aided design, and courses design to mechanical design, each of which is more or less mixed with the application of robot technology. For example, the knowledge of robot body motion and dynamics is blended into the course of machine and mechanism theory, which mainly enables students to master the calculation method of robot freedom, the principle of robot reducer, and the research ideas of robot body kinematics and dynamics.

##### **(2) Mechanical manufacturing practice ability training module**

The module consists of metalworking practice, fundamentals of mechanical manufacturing, mechanical manufacturing technology, NC machine tool and programming, computer-aided manufacturing, hydraulic and pneumatic transmission, advanced manufacturing technology and other courses of experiment and practice. Each of its courses is more or less mixed with the application of robotics technology. For example, in the hydraulic and pneumatic transmission course practice contains the choice of robot gripper drive cylinder.

##### **(3) Electrical transmission and control practice ability training module**

The training module of electric drive and control ability is composed of course experiment and practice links such as electric and electronic engineering, engineering control principal, mechanical and electrical transmission control, sensor and test, programmable logic controller, mechanical and electrical drive and PLC course design. Each of its courses is more or less mixed with the application of robotics technology. For example, the sensor and test Technology course practice includes a selection of sensors for robots.

##### **(4) Synthesis practice ability training module**

The ability training module of synthesis application (including robot application) is composed of electronic measurement and testing, robot technology industrial robot application, design method of mechanical and electrical system, course design to mechanical and electrical system, professional practice and other course experiments and practice links. Among them, the practice of robotics and industrial robots is directly robot technology, and professional comprehensive practice is integrated into the practice of robot innovation production and path planning, so as to guide students to participate in the production and competition projects related to robots.

#### (5) Graduation project (thesis) practical ability training module

The mechanical and electrical graduation design (thesis) is the last and most important practice teaching link in the training plan of undergraduate talents in mechanical and electronic engineering. Students who master the basic technical basis of robots are very willing to choose mechanical and electronic engineering graduation design (thesis) involving robot applications (more than one-third of students choose graduation design topics related to robot applications from social production practice). The teacher guides the students to comprehensively and intensively train the students to comprehensively use the robot application knowledge to solve the practical problems in the development or application of mechanical and electrical equipment through the topics of topic selection, proposal, research, design calculation, design drawing and writing design papers.

### **3.2 The effect of implementing the practical teaching system of mechanical and electrical profession mixed with robot application**

The mechanical and electrical professional practice teaching system mixed with the application of robots not only retains the traditional and classic training methods and training contents of mechanical and electrical talents, but also integrates the training of knowledge and ability in robot application through the upgrading method. The practice training of classical mechanical and electrical talents and the practice training of modern robot talents are effectively unified in a practice training mode.

The experimental practice teaching system of mechanical and electrical profession mixed with robot application technology has been put into practice for three years in applied mechanical and electronic engineering undergraduate profession. In the final graduation design practice teaching of mechanical and electrical profession, it can be seen that many students are willing to choose mechanical and electrical design topics including robot application, which fully shows that the robot application knowledge mixed with the mechanical and electrical practice teaching system is welcomed by students, and students are also welcomed and satisfied by employers after graduation.

## **4 Conclusion**

It is impossible to train qualified mechanical and electrical talents without corresponding experimental practice conditions and reasonable experimental practice system. Robot application technology is the development direction of contemporary new engineering and has broad application prospects. It is both necessary (conforming to the development of The Times) and possible (mechanical and electrical technology is the basis of robot technology) to mixed with robot technology. This paper discusses the construction and practice of practical teaching system of mechanical and electrical profession integrating robot application technology. The measures and effects are as follows:

- The practical teaching system uses a modular structure to mix robot technology into the classic mechanical and electrical practice course system according to the actual requirements of social production in the classic curriculum and traditional practical teaching links, indicating that the training of classical mechanical and electrical talents and the training of modern robot application talents in new engineering can be unified.

- The system has been run for three years by the applied mechanical and electronic engineering undergraduate profession, and the operation results show that the mechanical and electrical knowledge and ability structure mastered by the students is more adaptable to the social needs, and the robot application graduation project is widely welcomed by the students, and the students are more welcome and satisfied by the employers after graduation.

In short, for engineering undergraduate especially mechanical and electrical undergraduate profession, mixing robot application technology into the practice system is effective and worthy of promotion.

## References

- [1] L.Wang, Suxia.Ge, and Weiguo,Li: Exploration of robot practice teaching integrating moral education under the background of mass innovation and Innovation, Neijiang Technology,Vol. 43 (2023) No.3, p.25(In Chinese).
- [2] Z.Tang and F.Su: Construct the practical teaching curriculum system of robot engineering which integrates OBE concept, Chinese educational technology and equipment, Vol.23(2023),p.90(In Chinese)
- [3] Z.Han, Q.Wei and W.Li etc: The innovative teaching exploration of robot practice course integrating virtual simulation under the background of new engineering, Nanfang Agricultural Machinery, Vol.54(2023) No.14, p.159(In Chinese).
- [4] X.Yang, J.Guo and W.Hu etc: Training and Practice of Engineering Ability of undergraduate students majoring in Mechanical and Electronic Engineering, China Modern Educational Equipment, Vol.11(2019), p.75(In Chinese).
- [5] Y.Chen: Discussion on practical teaching reform of mechanical and electronic engineering specialty in universities, Educational circles, vol.27(2015), p.110-110,112(In Chinese).
- [6] T.Luo, G.Zhao and G.Chen etc : Research and practice on training new engineering talents for local economic and social development -- taking Mechanical and Electronic engineering as an example, Contemporary educational theory and practice, Vol.13(2021) No.3,p.8(In Chinese).
- [7] L.Yue and L.Yue: Research on the construction of robot practice teaching platform for mechanical and electronic engineering major in universities, Science and Technology Innovation Herald, Vol.14(2017) No.3, p.160 (In Chinese).
- [8] C.XU, L.ZHE, and X.LIN: The Research and Practice of Training Plans and Curriculums on Mechanical Professionals in Higher Technical and Vocational College. //2009 First International Workshop on Education Technology and Computer Science (ETCS). [v.1A].:IEEE, 2009:419-423.
- [9] ATHULA KULATUNGA. Integrating the Courses in Electrical and Mechanical Engineering Technologies to Fulfill the Need of Energy Professionals[C]. //2002 ASEE Annual Conference and Exposition. 2002:6-.
- [10]WU SENYANG, ZHANG LINCHU, QIAN JUN. Development and Application of Industrial Robot Teaching Experiment Platform Based on 3D Printing Technology[C]. //The 12th International Conference on Modern Industrial Training 2019:50-56.
- [11] YAPING LU, HEJIAN LIU. Construction of the Course System of Mechanical and Electronic Specialty for Applied Undergraduate Course--Teaching Direction of Industrial Robot[C]. //4th International Conference on Applied Materials and Manufacturing Technology(ICAMMT 2018) 2018:1-5.
- [12] EUGENE COYLE, AIDAN O'DWYER. Maintaining a balance at undergraduate degree level in

the teaching of automation and classical control system[J]. Measurement and Control: Journal of the Institute of Measurement and Control,2005,38(2):46-50.

[13] KARNVEER GILL, NICK MORALES, DAVID QUINTERO. A System-Level Approach for an Introductory Mechatronics Laboratory Course for Undergraduate Mechanical Engineering Students[C]. //American Society for Engineering Education Virtual Annual Conference and Exposition 2020: At Home with Engineering Education: Online, 22-26 June 2020, volume 19 of 30.:Curran Associates, Inc., 2021:15387-15398.