Virtual Experiment Teaching Innovation and Talent Training Mode of Electronic Technology of Measurement and Control Instrument

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Abstract. Experimental practice teaching is an important part of training engineering and technical talents who meet the requirements of "engineering education certification" under the background of "new engineering". For measurement and control instrument of electronic technology problems such as lack of comprehensive and systematic basic experiment course, carry out "an Omni-directional, multilevel and thus" experiment reform, build the progressive step by step, modular, the actual comprehensive systemic experimental teaching system, leading to the student ability raise as the center, forming a new measurement and control instruments virtual electronic technology experimental teaching system. The teaching practice proves that the teaching reform is effective, and the student's independent learning ability and comprehensive practice, and innovation ability are improved continuously, which is worthy of popularization and application.

Keywords: Electronic technology experiment of measurement and control instrument · Virtual simulation · Talent training · Comprehensive practice innovation

1 Introduction

Electronic technology base of measurement and control instruments is the core and fundamental course for measurement and control technology and instrument specialty in our university, with obvious practicality and engineering significance [1–3]. The specialty of measurement and control technology and instrument in our institute (referred to as "measurement and control specialty") has passed the second certification of the professional certification of Engineering education. Experts pointed out some problems that need to be improved, such as the experimental teaching mode is slightly single, the combination of comprehensive experiment and engineering technology application needs to be strengthened. Therefore, experimental teaching research of comprehensive talents training mode for measurement and control specialty oriented to engineering education certification has become the focus of experimental reform of measurement and control technology and instrument related specialties in Colleges and universities [4–7].

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2 Current Experimental Status of the Basic Electronic Technology of Measuring and Controlling Instruments

2.1 Current Experimental Status of the Basic Electronic Technology of Measuring and Controlling Instruments

Experimental of the basic electronic technology of measuring and controlling instruments mainly includes three theories: electronics technology, digital subcircuit and analog circuit. The content is varied and complex, and most of the experiments are validation experiments. The number of comprehensive design experiments is small and the difficulty is low. Due to the limitations of the experimental site, equipment conditions and equipment time, it is unavoidable that the comprehensive design experiments are simplified.

Before doing the experiment, the students had not been exposed to professional experiments related to electronic devices. Therefore, students need to start with the basic usage of universal tables, chip device unplugging, circuit wiring, signal introduction and so on. However, due to the different levels of students' practical ability, it is easy to have unclear understanding of components, inexperienced use of instruments, and confused circuit connection, which leads to most of the time wasted in the experiment on issues. However, due to circuit wiring errors and the lack of circuit detection skills, the students' experimental success rate is not high, so the ability required for the experimental goals can not be achieved. Gradually, the frustration of the experiment greatly reduces the students' enthusiasm for learning, and it is even less able to achieve the goal of improving students' innovative ability.

2.2 The Characteristics of Experimental Platform

Traditional experiments are based on the breadboards and then are gradually developed into larger, modular and more expensive integrated test benches or experiment boxes. The breadboard is very flexible to use, it has a large operating area, and is easy to switch on and off the power supply at any time. It can be used for large-scale experiments. However, its disadvantage is that the holes are dense and the unplugging lead is easy to loosen. For beginners, once the output signal of the circuit is wrong, it is difficult to check and it takes more time to detect the circuit. The integrated test bench partitions the circuit functions and pins of the components are separated. This makes it easy to inspect the circuit, but at the same time it will also bring potential failures, such as blocked IC socket, damaged power or signal source due to circuit wiring errors, and knob switch loss due to excessive force, which all require targeted maintenance of the experimental panel. The process is cumbersome and workload.

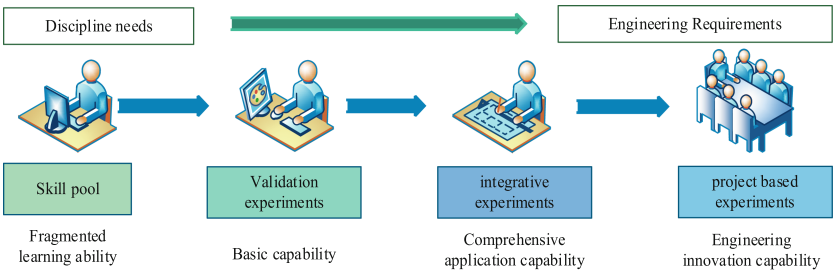

Fig. 1. The comprehensive and systematic experimental teaching systems

3 Exploration on the Experimental Reform of "All-Round, Multi-level, Combining Virtual with Real"

This paper studies the training points and methods of experimental innovation ability in the cultivation of new engineering comprehensive talents, forms the training scheme of experimental innovation ability, and carries out the reform and exploration of 'all-round, multi-level, virtual and real combination' measurement and control electronic technology experiment.

3.1 Constructing a Comprehensive and Systematic Experimental Teaching System of Progressive, Modular and Virtual-Real Combination

Combining with the characteristics of the experimental courses of measurement and control in our university, it is possible to integrate the experimental contents of public basic courses, professional basic courses and professional core courses organically. Explore the internal relationship of the courses based on the ability assessment, so as to build a modular course with the training of engineering technology application ability and quality as the main line. Relying on virtual simulation system, we can combine manual operation with virtual simulation to establish a comprehensive and systematic experimental teaching system, as shown in Fig. 1.

According to the basic theoretical arrangement, the experiment consists of three parts: electrical technology, digital circuit and analog circuit, totaling 32 h, which are divided into two semesters. Build a test and control electronic experiment skill reserve, sets up the experiment scheme centered on the training of students' ability, and combine virtual with reality to improve the experiment efficiency to form a set of experiment teaching system suitable for the characteristics of the subject.

3.2 Experimental Strategy

(1) Establish a measurement and control electronic experiment skill pool

Aiming at the current situation of limited experimental class hours and weak theoretical foundation of students, a comprehensive database of basic experimental skills is constructed. It mainly includes experimental auxiliary teaching resources, such as understanding of electronic components, instructions for using electronic testing tools

and instruments, experimental operation video explanation, circuit fault analysis, and instructions for using simulation software. Students can use fragmented time to learn about the experiment. This can improve learning efficiency, save classroom operation time, enable students to allocate experimental time mainly to experimental analysis, and lay a foundation for subsequent comprehensive experiments and subject competitions.

(2) Set up an experimental plan with "centering on the cultivation of students' abilities"

The reform of new engineering courses has shifted from discipline oriented to industry demand oriented to meet the development needs of new technology, and new industries. Students have less actionable content in confirmatory experiments. The experimental equipment can organically combine an integrated experimental platform with a flexible breadboard. The experimental projects can be set to progressive, such as validation experiments, integrative experiments and project based experiments. Validation experiments examine students' mastery of basic theories. Integrative experiments aim at the training of students' comprehensive ability. Project based experiments are mainly aimed at engineering practical ability and innovation and entrepreneurship ability. The experimental content combines disciplines such as electronic design competition, mechanical innovation competition, intelligent robot competition, and virtual instrument design competition.

(3) Improving Experimental Efficiency by Combining Virtual with Real

Due to the limitations of the experimental environment and experimental costs, the experimental content is slightly outdated and boring, which is not conducive to stimulating students' learning potential and potential. Starting from the need to cultivate innovative composite talents, it is urgent to carry out virtual simulation experiment teaching. The introduction of the Multisim virtual simulation platform into the experimental teaching of electronic technology for measurement and control instruments has the advantages of flexibility, convenience, and ease of implementation [8–10]. Multisim software simulation comes with rich components and test instruments, which can observe circuit node output parameters through simulation software, providing signal reference for practical circuit detection. Simulation software can be used for providing analysis and design references for device selection, unit circuit design, and system optimization of hardware circuits.

3.3 Constructing a New Atmosphere of "Interactive Teaching" in Experimental Teaching

With the rapid development of network technology and computer simulation technology, students have more channels to obtain professional knowledge. Therefore, Experimental teachers need to use various means to enrich teaching content and improve teaching methods. For example, led by discipline leaders, curriculum discussions are conducted in combination with specific scientific research and engineering technology commissions to form interactive teaching. Encourage theoretical and experimental teachers to jointly guide students to participate in various competitions to achieve a close combination of theoretical and experimental teaching.

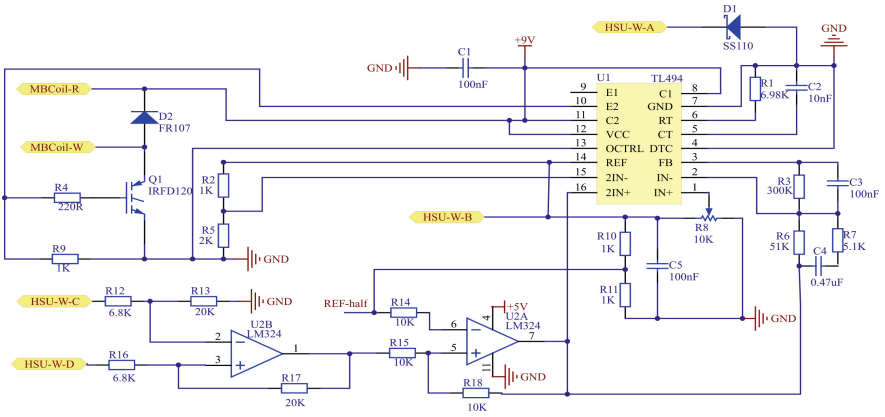

Fig. 2. Control schematic diagram of the upper suspended globe

4 Examples of Teaching Reform

Taking the project based experiment "Design of an Upper Suspended Globe" as an example. Firstly, by consulting information to understand the suspension principle. The control system includes a PWM control and adjustment circuit, a signal acquisition circuit, a comparison amplifier circuit, a power amplifier circuit, and a sensor detection circuit. These circuits are designed based on basic knowledge such as field effect transistors, operational amplifiers, PWM pulse modulation, and other principles. Such as, the hall sensors are used to implement a signal acquisition circuit. The collected signals are judged after passing through the adjustment circuit. The TL494 control chip pulse adjustment circuit drives the on-off of the power switch. Finally, the virtual software Multisim is used for design, and the circuit schematic diagram is shown in Fig. 2. Students with strong abilities can continue to conduct hardware design and production using the resources of the college's innovation base, achieving a seamless connection from simulation to physical objects, and achieving the goal of further cultivating students' engineering practical abilities.

5 Conclusion

Taking students as the center and oriented by engineering education concepts, we have carried out progressive, modular, and project-based experimental teaching reforms. The enthusiasm of students to participate in experiments has greatly increased, and the atmosphere of active learning has become increasingly strong. Students' hands-on ability, innovation ability, and ability to solve complex engineering problems in the engineering field have been cultivated. Of course, the reform of engineering education is sustainable, and we still need to proceed from curriculum practice, further optimize experimental content and methods, effectively implement the student quality training mechanism, and promote students to better adapt to comprehensive requirements such as social engineering skills.

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