

Thinking of Communication Technology Basic Laboratory Construction Based on Software Defined Radio Platform

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Abstract. In view of the current communication technology basic experiment teaching needs, this paper puts forward the thinking and planning of communication technology basic laboratory construction based on software radio architecture, and expounds the laboratory construction planning and significance based on software radio architecture and virtual instrument working platform on the basis of analyzing the construction needs. It provides a new perspective and thought for the construction of communication technology basic laboratory under the background of rapid development of information technology and rapid iteration and update of equipment.

Keywords: Software radio architecture; communication technology basic experiment; virtual instrument working platform.

1 Introduction

The construction of communication technology basic laboratory is an important content of higher education informatization construction and undergraduate specialty construction, and is the product of the deep integration of discipline and specialty with information technology. Communication engineering is an engineering major with strong practical characteristics. Course theories related to communication principles are abstract and difficult to understand, and its experimental equipment is closed and cost is high. However, with the rapid development of communication technology, the existing typical experiment box (platform) cannot bear experiments of 6G, OFDM and other high-tech.

Software radio technology [1] enables ordinary computers to work like high-bandwidth radio equipment. It is a baseband signal processing and intermediate frequency modulation equipment. It is simple, easy to develop and has strong universality. LabVIEW is a kind of graphical program development environment developed by NI company. It adopts the programming mode based on data stream and has rich library functions and communication interface functions. It can be used in cooperation with USRP and other software radio equipment to realize the sending and receiving function of radio signal and analysis and processing.

The basic laboratory of communication technology is built based on the software radio architecture to realize the teaching effect that the real experiment does not have or is difficult to complete. The teaching environment, teaching mode and method can better help the training of

applied talents in communication engineering out of the dilemma. The informatization of experimental teaching is regarded as the endogenous variable of the systematic reform of higher education, and high-quality experimental teaching is used to promote the transformation and overtaking of the teaching quality of higher education, so as to cultivate high-quality applied communication engineering professionals who can adapt to and support the development of the information society, so as to help the construction of a powerful country in higher education.

2 Demand for Experimental Teaching of Communication Engineering Major

2.1 Multi-course, small-class and multi-professional talent training needs

Different from traditional communication colleges and universities, which usually employ thousands of students, the undergraduate program of the college is characterized by "small classes and multiple majors". Take communication engineering as an example. There are two professional courses such as "Principles of Communication" and "Fundamentals of Wireless Communication", three basic courses such as "Signals and Systems", "Information Theory and Coding" and "Digital Signal Processing", and two basic professional courses such as "Random signal Analysis and Processing" and "Professional Design of Communication Engineering". In total, nearly 10 basic courses need supporting experimental conditions. If the traditional construction mode is adopted, a separate laboratory is established according to each course, and a variety of special teaching equipment is purchased, but it can only complete the experimental teaching of specific courses, and the equipment has a single function and low utilization rate. Different courses, need to build different laboratories; Different knowledge points, need to buy different special equipment. And limited by the traditional hardware experimental equipment fixed function, can not be changed and upgraded, easy to aging, obsolescence. There are many interdisciplinary fields in communication engineering, and the classification of experimental equipment is complicated. The major of communication engineering involves electronic and circuit, embedded and computer, signal analysis and processing, information theory and transmission, network planning and construction and other engineering fields, as well as natural science fields such as calculus and matrix, probability theory and statistics, semiconductor electronics, physics, electromagnetic field theory, optical device theory, etc. There are many kinds of experimental equipment to be used in teaching. It brings difficulties to the construction of communication engineering laboratory in colleges and universities, so the existing construction mode is not suitable for the special needs of undergraduate personnel training.

2.2 Requirements for the ability training of high-level interdisciplinary talents

Although the academic qualifications and abilities of teachers in colleges and universities have been greatly improved, due to the limitation of class hours and the number of students trained, experimental teaching is generally taught in large classes, which makes it difficult for teachers to give detailed guidance to all students and guarantee the teaching quality.

The purpose of carrying out experimental courses is to cultivate students' independent innovation and practical ability, while most traditional experimental teaching focuses on verification experiments. Generally, teachers explain and demonstrate the experimental

content first, so that students have a certain understanding of the experimental content, and then conduct hands-on verification. The experimental operation of this teaching mode is not highly trainable, which reduces the opportunity for students to observe and think, and to some extent imprisons their thinking. The experimental operation is too streamlined, resulting in the lack of exploration ability of students, which hinders the cultivation of talents.

Communication major involves a wide range of knowledge, which requires a good foundation of mathematics, physics and strong practical application ability. Some courses, such as data structure, operating system, database, etc., belong to computer; Others, such as signal processing, high-frequency circuit and circuit principle, belong to the electronic category. There are also the core courses of this major, such as communication principle, signal system and wireless communication foundation. These courses have abstract and complex principles and broad learning scope, requiring students to have strong logical thinking ability and imagination. There are some problems in traditional experimental teaching, such as insufficient reliability of experimental equipment, single supporting resources, unstable experimental phenomena, and imperfect testing equipment, which lead to too single means of observing experimental results, affecting the verification and understanding of theories, and causing a large gap between students' current professional level and the national "innovative talent cultivation strategy". It has not yet formed mature thinking and mode of training innovative talents, and can not meet the urgent needs of high level compound talents ability training.

2.3 Real-time update iterative requirements of the experimental system

The low-frequency general equipment and instruments in the laboratory of communication engineering include voltage regulated power supply, signal source, frequency sweep instrument, multimeter, oscilloscope, etc. Such instruments and equipment have been fully localized, with moderate price, excellent quality and perfect supporting services. Colleges and universities can generally complete the purchase, maintenance and update of such instruments and equipment relatively easily. However, with the rapid development of the electronic information industry and the rapid development of satellite communication technologies of microwave and millimeter wave frequencies worldwide, the high price of VHF, radio frequency and microwave equipment with low localization, such as spectrum analyzer, network analyzer, signal source, etc., makes it difficult for colleges and universities to meet the needs of building a comprehensive test platform and building comprehensive radio frequency laboratory equipment. The experimental teaching of communication engineering specialty faces the practical problem of hardware shortage.

At the same time, the rapid development of communication technology requires the continuous updating of teaching content, the upgrading of relevant experimental teaching equipment, and the endless emergence of advanced equipment. The construction cost of traditional laboratory is high, and the maintenance work is complicated and difficult, from the human, financial, time, space and other aspects of the laboratory has always restricted the innovation and construction of the laboratory, there are old and backward experimental equipment, teaching experiment project invariable, imparts knowledge lag, students' interest in learning greatly reduced, teaching effect greatly reduced and other problems.

To sum up, it is an important means to solve the existing problems in the experimental teaching of college communication engineering majors to use the software radio platform to assist experimental teaching, combine the software radio technology with practical operation, and build the communication technology basic laboratory.

3 Communication Technology Basic Laboratory Planning And Construction

3.1 Establishment of software radio platform

Software radio platform [2] is a functional system built by using software radio technology and its supporting development hardware. It is used to complete the whole process of various experiments and is the core functional component of the whole system platform.

(1) Using a typical software radio architecture, the digital IF signal of the broadband RF front-end is sent to FPGA for digital signal processing to complete the hardware function of the communication system; (2) Support docking with third-party simulation software such as Matlab and GNURADIO, which can combine modules in different ways according to the experimental intention to build different functional entities or systems, and freely adjust the relevant parameters of modules; (3) Support docking with common platforms such as NI USRP, Hackrf and ADI PLUTO, and build real-time communication system; (4) Deployed between the platforms on different PCS, the management terminal can realize remote cooperation to complete the overall system design and joint commissioning.

The construction of software radio platform [3] can not only realize pure virtual experiment and secondary development and design, but also realize real-time interconnection and co-simulation and other functions, so as to truly provide learners with a vivid and realistic learning environment of shared experiment system.

3.2 Establish an air port signaling platform for wireless communication

The air port signaling platform can capture and display the underlying data packets of the communication between the mobile phone and the base station in real time, and analyze the data in real time according to the air port protocol specification. The platform supports the visual display of the collected protocol message name, message type, channel type and original hexadecimal data, and should support the screening and search of protocol message types, convenient for students to study and analysis.

3.3 Establishment of laboratory information management system

Through the establishment of laboratory information management system to achieve the unified control and management of equipment in the classroom, including projection curtain lifting, equipment switching machine, sound adjustment, air conditioning control, lighting control, curtain opening and closing intelligent control. At the same time, an experiment reservation system is established to meet the requirements of the independent open experiment teaching system model. After the teacher determines the open experiment resources and the teaching resources are reviewed by the teaching administration department, students can obtain the opportunities of independent open experiment practice and training. The system can

automatically open and share the limited simulation experiment resources, which can effectively solve the problem of resource use conflict and optimize the utilization of resources.

3.4 Establish teaching task management system

The establishment of a teaching task management platform will support the unified storage and management of various basic resources of teachers' experimental courses, such as videos, instruction manuals, teaching plans, learning reference materials and experimental simulation software, provide resource sharing function, classify management by content type, support online cloud disk management, development and sharing and other parameter features. At the same time, the task layout function is developed, the object of the task is designated, the task completion of each student and the experimental process data are constantly checked, and the experimental report uploaded and submitted by students is reviewed online.

3.5 Establish a teaching resource management system

The teaching resource management system is established and used as a unified system access portal to access various virtual simulation experiment projects, so as to provide whole-process closed-loop management of "reservation-experiment-monitoring-evaluation" for the experimental teaching process of teachers and students, build advanced scientific research environment, whole-process teaching management and dynamic evaluation mode, so as to meet the needs of teachers and students' teaching experiments. At the same time, the virtual simulation test system is created to realize the functions of the random unit test paper, automatic batch test paper, analysis and statistics automation of test paper, so as to improve the marking efficiency and avoid manual marking errors.

4 Value of Communication Technology Basic Laboratory Construction

4.1 Build an efficient learning environment

Construction of basic communication technology laboratory, development of networked experimental teaching platform with virtual simulation experiment function, formation of virtual-real combination of communication network and technology experimental teaching system, which can easily allow teachers and students to interact with equipment network, visually present and dynamically evaluate the process and results of experimental operation. Effectively solve the problems of updating pressure of new physical equipment, contradiction between small experimental site and large number of students, repeated construction of experimental conditions but low utilization rate. In addition, with the help of virtual simulation experiment teaching system, students can realize all-weather learning mode, allowing students to independently choose learning progress, learning time and learning content, so as to achieve efficient learning.

4.2 Realize the assessment of efficient teaching management

The laboratory integrates virtual reality, multimedia, human-computer interaction, database and network communication and other modern technologies, focusing on the core courses of communication engineering major: The experimental teaching needs of communication

principle, signal system, digital signal processing and information theory, and the construction of virtual experimental environment combining virtual-real and highly simulated, support the students of "communication engineering" and other majors through online and offline combination of related course experiments. At the same time, the network, remote control, virtualization technology, etc. can bring the experimental links to the theoretical classroom, the experiment pre-class preview, class guidance and after-class review on the line, reduce the teachers in the teaching of repetitive work, efficient management of experimental teaching resources, so that teachers focus on the construction of experimental content.

In order to improve students' self-learning and practical innovation ability, information technologies such as MOOC teaching management platform, project development management platform and college students' innovation and entrepreneurship training platform are adopted to deeply integrate traditional experimental teaching methods with modern information technology and realize diversified experimental teaching. At the same time, the experimental assessment mechanism should be reformed, diversified experimental assessment methods should be established, experimental process and experimental results should be coordinated, and students' learning attitude, project development, design and development ability and innovation and entrepreneurship ability should be comprehensively evaluated during the experimental process, so as to ensure the effectiveness and scientificity of the evaluation and improve students' experimental interest and ability.

4.3 Enrich teaching resources and realize interactive through-learning

Unified online and offline management of the laboratory can manage physical experimental equipment resources[4] and virtual simulation software, and bring online and offline resources into the experimental teaching process through unified introduction of experimental teaching activities to provide consistent use experience.

The software radio platform is based on the underlying communication simulation engine, and integrates virtual reality, multimedia, human-computer interaction, database and network communication and other technologies to build highly simulated experimental environment and experimental objects. Students carry out experiments in the environment to achieve the teaching effect required by the syllabus, achieve the purpose of combining virtual-real and mutually complementary, and have expansibility, compatibility and forward-looking.

Develop experimental teaching functions that are not available or cannot be realized under current technical conditions. With the rapid development of communication technology, traditional experimental teaching equipment can not fully adapt to the demand of experimental practice teaching at the present stage. For example, for complex and heterogeneous wireless communication environments, there are clear demands for talent training and teaching practice, which also leads to the development of relevant teaching activities only by relying on software radio technology.

4.4 Realize the openness and freedom of the laboratory

It alleviates the dependence on laboratories and experimental instruments in the process of experimental teaching, solves the problem of insufficient experimental sites and experimental instruments in universities[5], provides material guarantee for innovative scientific research

and experimental competitions, reduces the difficulty of laboratory management, and realizes the freedom of experiment and personnel management to a certain extent.

Adhere to the "student-centered", the establishment and construction of "independent, collaborative and innovative" learning model. Corresponding to the "trinity" experimental teaching system, autonomous learning corresponds to basic experiments, cultivating students' ability to apply basic knowledge and practical skills; Collaborative learning corresponds to comprehensive experiments, and cultivates students' ability to design systems and deal with complex problems; Innovative learning corresponds to innovative experiments. Students' innovative spirit and ability can be cultivated by participating in teachers' scientific research projects, electronic design competitions, programming competitions and other discipline competitions.

5 Conclusions

Experimental teaching is an important part of undergraduate education. Laboratory construction, as a development direction of the experimental teaching of communication engineering major, adopts the software radio architecture to build the laboratory in response to the demand of multi-course, small-class and multi-specialty talents cultivation, which solves the problems of fast equipment updating and iteration, high hardware cost and low utilization efficiency. Through the construction of software radio architecture experiment, this paper promotes the reform of students' experimental teaching methods such as independent learning, cooperative learning and innovative learning, enrich teaching methods and experimental content, arranges experimental resources, reduces experimental costs, and improves students' practical ability, innovative ability, and ability to analyze and solve problems. Enhance the discipline construction of high - level, innovation, challenge degree.

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