Exploration on Diversified Practical Teaching Mode of Digital Signal Processing Course Combined with FPGA

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Abstract. According to the teaching arrangement of digital signal processing course in electronic information specialty, the problems existing in the practical teaching process are analyzed in the paper. From three aspects, we discuss the construction of the diversified practical teaching mode combined with FPGA. Firstly, we can build several FPGA innovation laboratories, improve the practical teaching platforms, and perfect the operation of innovation laboratories. Secondly, we can adjust the teaching plans and practical teaching contents, and use the case teaching method combined with FPGA. Thirdly, we can extend teaching from classroom to extracurricular, and implement the credit system of innovation and entrepreneurship in a second classroom. This kind of diversified practical teaching mode is helpful for undergraduates to learn the course of digital signal processing well, and at the same time, it can better cultivate undergraduates' hardware thinking mode and innovation ability.

Keywords: teaching reform, digital signal processing, diversified mode, FPGA, practical teaching.

1. Introduction

In recent years, in order to adapt to the development of the new industrial revolution, the Ministry of Education of the People's Republic of China has been vigorously promoting engineering education accreditations [1] and new engineering course constructions [2], adjusting the structures of disciplines and specialties, and improving the connotation of engineering education. Among the engineering majors in China, electronic information majors account for a large proportion. Digital signal processing course is one of the core professional courses of this kind of majors. This course is mainly about algorithm discussions and theoretical derivations, involving a lot of mathematical knowledge. Therefore, many undergraduates are afraid of and tired of learning this course. How to help them overcome those negative emotions, stimulate their interests in learning, and master the theories and practical skills of this course is an urgent task of teaching reform.

Practical teaching is the necessary link to learn this course well, and the teaching mode needs to be improved continuously [3]. Starting from the reforms of practical teaching, exploring the diversified practical teaching modes can improve undergraduates' learning interests. At the same time, it can make the theoretical teaching and practical teaching of digital signal processing course complement each other and improve the teaching quality with the help of practical teaching.

2. Disadvantages of the Existing Practical Teaching Mode

The course of digital signal processing has the characteristics of combining theory with practice and combining principle with engineering application closely. Practical teaching is the important part of this course. However, the existing practical teaching mode has many disadvantages, so the learning effect of undergraduates is not ideal. These disadvantages are shown in three aspects: practice places, practice platforms and practice content, as illustrated in Figure 1.

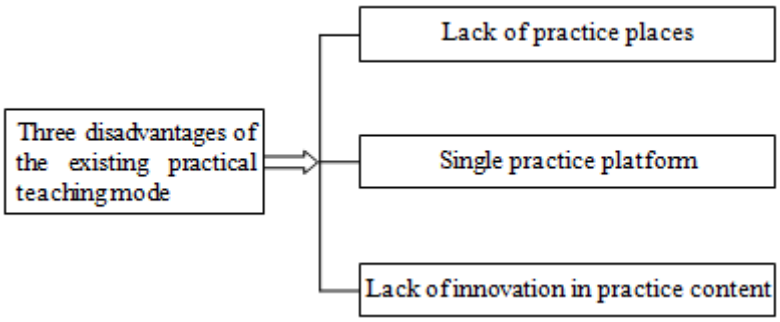

Fig. 1 Three disadvantages of the existing practical teaching mode

First of all, there is a lack of practical teaching places for undergraduates in our university. Certainly, most colleges and universities have similar problems. For postgraduates, they can enter their supervisors' laboratories to complete their research tasks. However, there are few opportunities for undergraduates to enter the research teams of postgraduates. There are at least two reasons. The first reason is that the number of undergraduates is so large that it is difficult for those postgraduate laboratories to accommodate so many undergraduates. The second reason is that the knowledge structures of undergraduates are not perfect, so it is difficult to complete some scientific research tasks with certain difficulties.

Secondly, the form of practical teaching platform of digital signal processing in our university is single. At present, only MATLAB is used to complete the simulation experiments of signal processing algorithms on PCs.

Thirdly, the main contents of practical teaching are some confirmatory experiments. The experimental instructions have provided most of the program codes, so it is very difficult to improve the innovation ability and comprehensive quality of undergraduates.

Through interviews and questionnaires, it is found that those undergraduates prefer to learn boring theoretical knowledge through real hardware platforms. Therefore, under the limited arrangement of class hours, we should study how to guide undergraduates to make full use of professional laboratories and innovation laboratories, and use FPGA hardware development platforms to actively complete the practical learning tasks of digital signal processing course. Moreover, we should extend the teaching from classroom to extracurricular, and bring the extracurricular scientific and technological activities of undergraduates into the process of innovation ability cultivation.

3. Construction of the Diversified Practical Teaching Mode

In order to improve the connotation of engineering education and better complete the construction tasks of electronic information majors, it is necessary to reform the diversified practical teaching mode of digital signal processing course. We need to ensure the "Three Combinations", namely, the combination of in class and out of class, the combination of teaching and scientific research, and the combination of teaching and practice. Thus, there are three measures of teaching reform of the course of digital signal processing. The first measure is to build several FPGA innovation laboratories. The second measure is to adjust the teaching plans and practical teaching contents, and use the case teaching methods combined with FPGA. The third measure is to extend teaching from classroom to extracurricular, and implement the credit system of innovation and entrepreneurship in the second classroom.

3.1 Build Several FPGA Innovation Laboratories

The existing practical teaching is based on MATLAB software or a practical teaching platform combined with DSP processors [4]. However, DSP processors have some shortcomings in processing speed, hardware flexibility, development efficiency, intellectual property and so on. The mainstream FPGA devices have embedded DSP modules. Using FPGA devices to build digital

signal processing systems for practical teaching can not only avoid many shortcomings of DSP processors, but also provide undergraduates with practical teaching platforms to realize digital signal processing in a hardware way.

In order to facilitate the undergraduates to carry out experiments, electronic designs and productions in extracurricular time, several FPGA innovation laboratories should be set up. In this way, it can provide practice places for undergraduates to complete the extracurricular experimental projects or productions that they are interested in.

In addition to the digital signal processing course, FPGA devices can also be used to complete the corresponding experiments of other courses. For example, digital circuit, microcomputer principle, single-chip microcomputer technology, communication principle, digital image processing and other courses. Therefore, FPGA experimental equipments have great applicability and expansibility. After completing the required practical learning tasks, undergraduates can play their imagination and creatively conceive and develop novel and original electronic equipments.

3.2 Adjust Teaching Plans and Practical Teaching Contents, Use Case Teaching Methods

In order to deepen the undergraduates' understanding of the theories of digital signal processing and improve their abilities to solve practical engineering problems, we can try to optimize the contents of experimental courses. We can try to reduce the basic and confirmatory practical teaching contents, and add some comprehensive, exploring, innovative and open practical teaching contents [5]. In this way, the ability to solve practical engineering problems and innovation ability of undergraduates can be cultivated.

For the digital signal processing system based on FPGA devices, we can design many kinds of digital filters flexibly by using hardware description languages, and it is convenient for seamless transplantations of different types of FPGA devices. Hence in the practical teaching contents, we should try to add some teaching contents of digital signal processing system design combined with FPGA [6, 7]. In the alternative subjects of course experiments and graduation projects, we can also try to add some research subjects of digital signal processing system design combined with FPGA. For instance, the case teaching method can be utilized to allow undergraduates to design IIR and FIR digital filters using a certain hardware description language. We can choose a suitable hardware description language between VHDL and Verilog HDL to complete the design tasks.

3.3 Implement the Credit System of Innovation and Entrepreneurship in the Second Classroom

In order to cultivate the innovation and practice abilities of undergraduates, we need to extend the teaching from classroom to extracurricular. We can implement the second classroom system and try to add extracurricular credits in the teaching plans [8-10]. We imagine that undergraduates can utilize their extracurricular time to complete independent and innovative experimental projects beyond the requirements of the course of digital signal processing, and gain extra credits. Undergraduates can combine their own interests and needs to find research topics and tasks they are interested in. In this process, undergraduates can choose supervisors, let them give some appropriate guidance, and finally complete the practical tasks independently. Through this kind of open practical teaching, we can enhance undergraduates' self-confidence in solving problems independently and cultivate their interests in the course of digital signal processing.

4. Summary

The construction of FPGA innovation laboratories can better cultivate the hardware thinking mode of undergraduates and help them form a comprehensive and complete understanding of digital signal processing system. At the other hand, in the form of the credit system of innovation and entrepreneurship in the second classroom, the previously neglected extracurricular activities can be included in the practical teaching plan of the digital signal processing course. Some comprehensive, exploratory, innovative and open practical teaching contents can be added, which

can provide an important way to cultivate undergraduates' ability of solving practical engineering problems and innovation ability.

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