Reform of Digital Signal Processing Course for Postgraduate Education

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Abstract—**In this paper, reform attempts in the aspects of basic theory, experiment simulation and engineering practice are carried out in order to resolve the practical problems in the course "digital signal processing" teaching process. Reforms are focused ones sential training, and deeply analyze the classic contents of digital signal processing by using the method combined theory teaching with simulation experiments. Algorithms commonly used in engineering are designated as the contents of simulation experiments. Complete engineering projects are treated as practice topics. Through this reform practice, postgraduate students have been greatly improved in autonomous learning, engineering practice and team collaboration. At the same time, the reform lays the foundation of their future research tasks.**

Keywords-digital signal processing; teaching reform; simulation; engineering practices

I. INTRODUCTION

Digital signal processing course is an important degree graduate class of electronics, control and information, which basic theory, basic method and basic implementation method is widely applied in many related areas and it lays a solid foundation for the students who will engage in theoretical research application development and technical management in the future [1-2]. This course is a very strongly theoretical course involving a very wide range of knowledge. However, the graduate students' sources are complex, their basis and knowledge structure is different and the student's requirements on the digital signal processing course are also diversified [3]. We reform this course according to the characteristics. The reform is integrated designed in basic theory, experimental simulation and engineering practice.

II. INTEGRATION OF BASIC THEORY

In order to enable students to master the basic knowledge and skills of the courses in the shortest period of time, it is particularly important to select the content of teaching and straighten out the curriculum system [4].Under the guidance of this principle, we have integrated a variety of digital signal processing materials, discarded the dross and selected the essence, and the organic integration of curriculum content was obtained, summing up a number of knowledge points. According to the sequence of obtaining, analyzing and processing of digital signals, the purpose of keeping pace with time is attained combined with the introduction of frontier knowledge in the process of teaching. The structure of the whole theoretical knowledge is shown in Figure I.
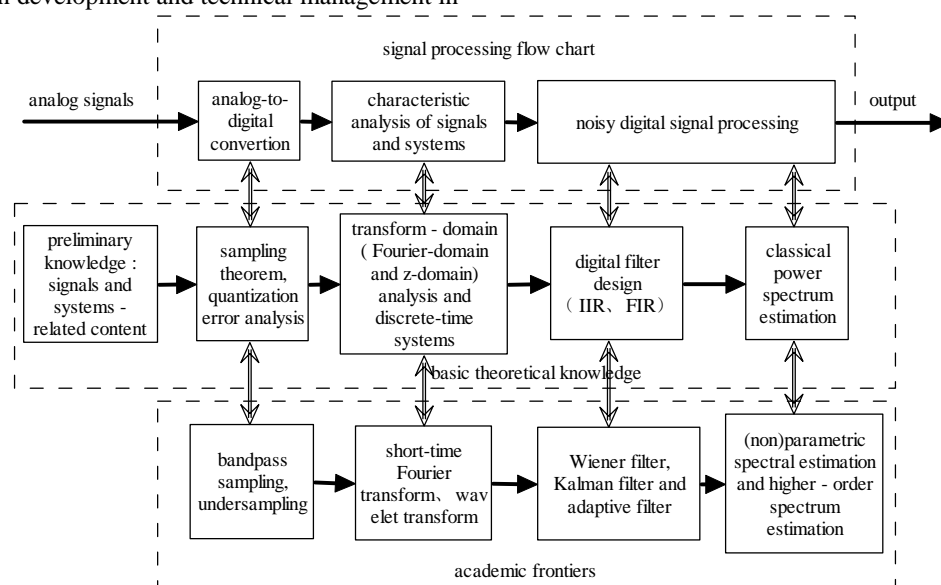

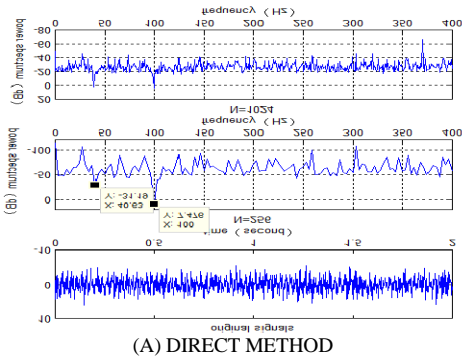FIGURE I. FRAMEWORK OF THE THEORETICAL KNOWLEDGE

We have integrated a variety of digital signal processing materials, discarded the dross and selected the essence, integrated the curriculum content organically, and summed up a number of knowledge points. We obtain simplified basic theories according to the procedure of digital signal acquisition, analysis and processing and keep pace with time with the introduction of frontier knowledge in the process of teaching.

In the implementation of the teaching process, the careful organization of basic theoretical knowledge is focused to be explained. We reduce some tedious theoretical derivation, pay great attention to the corresponding relationship between mathematical and physical properties of the theory, and emphasize relevance of knowledge and the physical meaning and application of conclusion. As for the introduction of the frontier knowledge, the comparison method is used to explain their difference with basic theory and their engineering application. This framework not only meets the needs of poor students, but also makes better students to be developed.
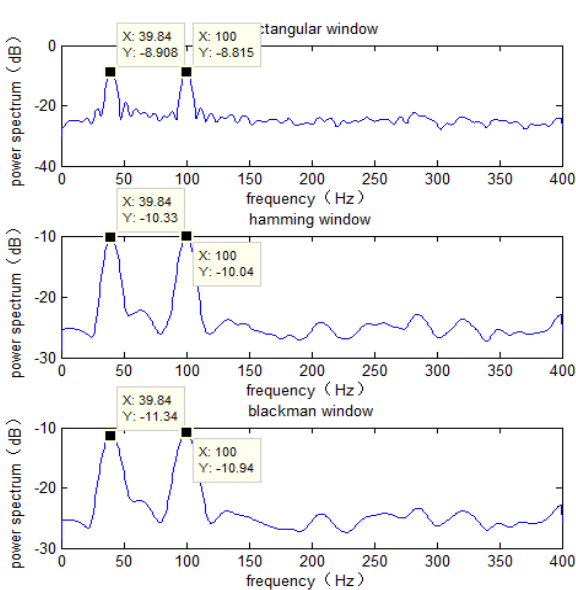
III. SIMULATION EXPERIMENT

The simulation experiment is an important part of cultivating graduate students' application ability. According to the signal processing flow, four MATLAB simulation experiments were designed in accordance with the process" how to acquire digital signal, how to analyze the characteristics, how to filter out the noise, and how to estimate the spectrum": (1)signal sampling and reconstruction;(2) correlation, convolution and its implementation in frequency domain;(3) design and implementation of FIR filter;(4) comparison of different power spectrum estimation. These content and the basic theory of knowledge have close relationship, so that students learn to use simulation software, grasp the theoretical knowledge profoundly, and understand how the theory and engineering practice is combined at the same time.

For example in experiment 4, the students achieve the simulation of two basic methods for classical spectrum estimation: direct and indirect method. On the basis of this, the improved methods, Bartlett average cycle graph method and Welch's method, are simulated. And the results of different window functions were compared in Welch method. Summary of the application of various methods and comparison with theories verified the theoretical knowledge, so as to enhance the understanding. Some simulation results are shown in Figure II.

(A) DIRECT METHOD

(B) WELCH METHOD

FIGURE II. SIMULATION RESULT OF POWER SPECTRUM ESTIMATION

IV. ENGINEERING PRACTICE

According to the idea of digital signal acquisition, analysis and processing, we design comprehensive experiments in control, communications and other related areas to focus on solving problems in integrated design and theoretical knowledge application. Based on the actual demands, all students are divided into several small groups in terms of their research fields or interests. Each group is formed by two or three students. They cooperate with each other and carry out experimental research and exploration by writing simulation code, demonstrating simulation results and writing experiment reports, which can effectively improve their abilities of engineering practice and thesis writing.

For example, the detection of direct sequence spread spectrum signal in communication can be used as a practice. Its corresponding simulation process, shown in Figure 3, includes sampling theorem, FIR low-pass filtering, convolution via FFT and other course contents, which make the students have a more intuitive understanding of signal processing system.
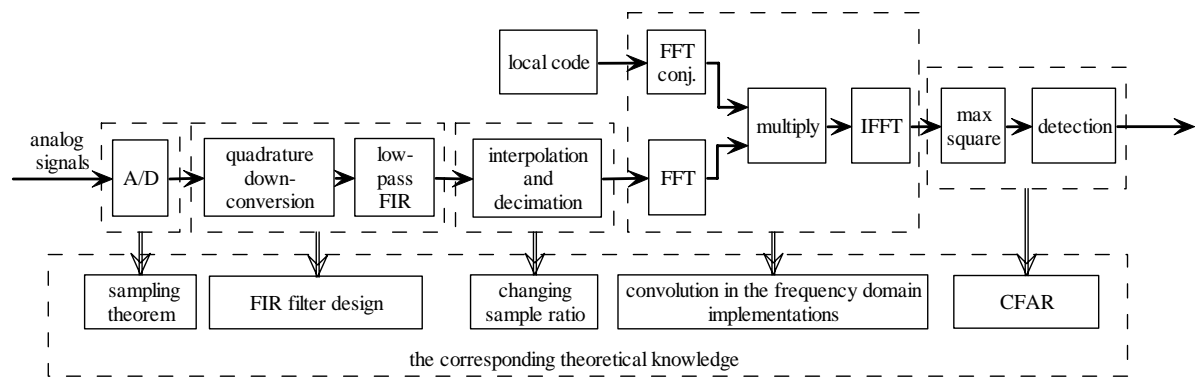
FIGURE III. EXAMPLE OF THE PRACTICE

V.   CONCLUSIONS

Based on the characteristics of digital signal processing courses for graduates, this paper analyzes some problems in the teaching process of the course and explores some feasible reform in basic theory, experimental simulation and engineering practice to solve these problems. The reform not only enables students to master the basic theory of digital signal processing, but also improves their application and innovation abilities of self-learning, engineering practice, scientific innovation, thesis writing and team collaboration, etc. Therefore, the main aim of the teaching reform has been accomplished. Since this reform has just begun, it needs to be improved gradually during teaching. We plan to use MOOC method in the following reform, which asks students to preview the contents in their spare time and think about questions in the course, so that their self-learning ability and innovation mind can be developed.

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