

# *Research on Experimental Teaching Reform of “DSP Principle and Application” Course for Undergraduate Student*

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**Abstract**—There is much difficulty for the teaching of “DSP Principle and Application” which need strong support of experiment teaching, because of its strong synthesis and engineering, fewer class hour as well as too much content. A innovation has been processing, which is innovated from instrument, material and content of teaching as well as evaluation, according to few years teaching experience with actual condition for our students. It is probed by small class teaching that we have achieved good effect and get the affirmation of other teachers in our department.

**Keywords**—*DSP Principle and Application; experiment teaching; innovation; effect evaluation;*

## I. INTRODUCTION

With the rapid development of information and electronic technology, digital signal processing (DSP) technology is widely used in communications, medical imaging, radar and sonar, high fidelity music weight system, inverter control and oil exploration and other fields[1][2]. Therefore, it is important to know and master the relevant technology of DSP, which has important practical significance to the graduates of the University. In addition, Similar to the "single chip microcomputer principle and application" and "programmable logic device", "DSP principle and application" is a typical application course. Such courses general preliminary requires students to master the basic theoretical knowledge of related devices, programming method and simple engineering application[3][4][5]. To ensure students to get an ideal job after graduation from our non well-known colleges, it must put forward advanced requirements that our student should to skilled use of device programming, development and Application.

"DSP principle and application" is a practical and relatively strong professional course, which is a practical

course after the course of the "single chip microcomputer principle and application" and "programmable logic device"[6][7][8]. Due to its comprehensive and strong engineering, emphasis on application, and need more the relevant basic courses, theoretical teaching is difficult. Therefore, to obtain more ideal teaching effect, it needs the strong support of the corresponding experimental teaching, which puts forward higher requirements for the experimental teaching of the course[5][9]. Based on many years of teaching experience, combined with the actual situation of HuBei engineering University, "DSP principle and application" experiment teaching reform has been done. From now on, the experimental teaching reform has a better effect, and is a good helper and support for the theory learning

## II. THE NECESSITY OF THE TEACHING REFORM

At present, there are some problems in the experimental teaching of "DSP principle and application" in our school:

- Our students Lack of real experimental teaching and the perceptual knowledge of DSP hardware. For various reasons, the "DSP principle and application" experiment teaching in our school still remain at the stage of computer simulation, and lack of hardware experimental teaching equipment, students lack the knowledge of DSP hardware, so the theoretical teaching has no strong support.
- The contents and learning order are unreasonable. Due to lacking hardware experimental equipment, it cause to some experiment cannot be carried out. So the experimental teaching content is restricted by the computer simulation. Furthermore, the content order is not consistent with the existing knowledge structure, it easy to cause the students' boredom.

- Our students are lacking of targeted textbook. Foundation of the students in our school is relatively poor, while the practicability of the "principle and application of DSP" is too strong, so there is no suitable textbook can be directly used in the experimental teaching, and it causes to more difficulty to teaching and learning.

There may also be some other problems in the experiment teaching, and it will not be described here. Overall, the opened time for the course of "DSP principle and application" in our school is short, fewer teaching experience is obtained by teachers, student foundation is weak, and theoretical teaching and experimental teaching difficulty are very large, so it is necessary to reform of the experimental teaching, to explore the best experimental teaching model for students in our school.

### III. THE REFORM OF THE EXPERIMENTAL TEACHING

It is well known that the course of DSP principle and application are more and more difficult to learn, because of its more basic theory, strong application, and fewer class hours[10][11]. As the support of theory teaching, the experimental teaching of "DSP principle and application" must be based on the students' foundation, and put forward the reasonable experiment contents in order to obtaining better teaching effect. So the reform for the experiment teaching of "DSP principle and application" in our school is described below:

#### A. teaching instrument and textbook

The template is designed so that author affiliations are not r At present, almost all the colleges teaching for this course are carried out through the teaching box which be widely used in some college experimental teaching and computer simulation. While DSP peripheral circuit and peripheral interface circuit is often hidden for the experimental box, and due to its complete peripherals, and interface configuration, it is easy to cause dependence psychology. Relatively speaking, the hardware of development board is intuitive, all kinds of interface set aside for students to free play, and provide relatively open circuit diagram of the development board. So it is conducive to enhance students' understanding of the hardware circuit. So to getting better teaching effect, development board of the TMS320F2812 is used directly in experimental teaching.

In the textbook, the existing teaching material and self-designed teaching material is combined to use. Where the self-designed teaching material is mainly based on the training course, and is more suitable for our school students. Therefore, the early teaching is based on self-designed teaching material, but the later system theory study needs to reference to the literature.

#### B. Content and class hours

In order to making our students master the DSP development technology, and to ensure that the students have the ability to programming and development of DSP processor, we have designed a targeted experimental teaching plan, and the specific content and class hours is described in table 1.

TABLE I. THE CONTENT, ORDER AND CLASS HOUR FOR THE EXPERIMENTAL TEACHING<sup>①</sup>

Numbers	Main content	Class hour
1	the environment and operation for CCS development tool	2
2	The edit for CMD files	2
3	The programming for the configuration for the interrupt and system clock of the TMS320F2812	2
4	The programming for the configuration for Event Manager (EV) of the TMS320F2812	4
5	The programming for the Serial Communication Interface (SCI) of the TMS320F2812	2
6	The programming of the configuration and correction technique for Analogy-Digital Conversion(ADC) of the TMS320F2812	2
7	Algorithm application programming for DSP processor, such as IIR filter, FIR filter and FFT	2
8	Comprehensive design experiment, and the design task is from teachers or student interest	2

<sup>①</sup> Most experiments are dominated by students and teachers do not provide the existing procedures.

In the experiment one, the CCS development software and its some commonly used operation, such as program compiling, loading, running, register data view, and so on, are the main tasks. In addition, the students should also be further familiar with the DSP development language - C language and this experiment provides the experimental procedure. Experiment two mainly requires students to master the meaning of the CMD file, and the programming when need to expand the FLASH memory

in particular. Experiment three requires students to switch interrupt and clear the interrupt flag, and master the programming of system clock configuration. Experiment four is the key part of the experimental teaching, which is divided into two stages. The first stage requires students to master the EVA timer and the programming method of generating PWM wave. The second stage requires students to master the dead time control register and the use of the capture unit. Experiment five requires students

to master the programming and debugging method for SCI peripheral. Experiment six requires students to master the use of conversion and programming methods of ADC peripheral in the F2812, and the correction technique for ADC errors when a large error occurs. Experiment seven will return to the concept of DSP professional processor. The some typical DSP algorithms should be realized through the C-language, according to theoretical knowledge of the digital signal processing, and the specific content is not limited. Experiments eight is the comprehensive design experiment. Some related experimental subjects can also be designed by student, should be provided by teachers, and its difficulty is not restricted, while these subjects must contain hardware design. The aim of this experiment is training the ability for the design of hardware and software and overall understanding for TMS320F2812.

### C. Experimental teaching assessment

Examination of the experimental course should be combined with theory course evaluation, other than independent assessment, and the total score for the student is the weighted sum of the score of the open book examination and designing experiment. In the design experiment, the group, consisted of 2-3 students, should carry out the design and development based on the DSP2812 development board. The design task is self-provided and should be examine and verify by teachers to avoid repeating. The evaluation of the design task needs to make open reply for a few minutes.

In addition, in order to enhance the students' interest in further study of DSP technology, we have put forward a new evaluation method that is the students who want to engage in the development of DSP technology, can be delay and reference the effect of the graduation design and the writing of the paper.

### D. Teaching Effect Evaluation and Eutlook

All the students completed the program design experiments; the teaching achieved good results, some students in the experiment of the DSP peripheral control program is beyond the teacher's expectations. For example, some students have found that the DSP in the use of improved Harvard structure, multi-bus, parallel operation and hardware multiplier and other measures to effectively improve the operating speed, but also brings some new problems and new challenges, such as: pipeline conflict, pipeline blockage, etc..

A lot of students are together to discuss, put forward their own views, some students think it should be correct to set up the hardware or initialization control register, in order to make the DSP can be full speed or have the task waiting for. Some students think that one algorithm can be decomposed into different parts of the hardware in order to obtaining the Uniform distribution of the calculation and improve the running speed, etc..

Although some results have been achieved, there are still some shortcomings in the work that need to be improved, as shown below.

- Due to fewer hours of experimental course, other peripherals for interface design of DSP, DSP / BIOS, etc. are not arranged the experiment content. as a supplement for experiment teaching, we want set up experimental technology seminars, presents experimental requirements and provides an example program in order that lets interested students to carry out laboratory exercises in class
- Since the experiment content is in line with the curriculum design, intended to develop a presentation courseware development tools, allowing students to quickly master the use of DSP tools in order to improve the level of curriculum design.

We Hope that it will make our school DSP experimental teaching to a higher level through these measures, it is possible to strengthen the DSP Laboratory.

## IV. CONCLUSIONS

"DSP principle and application" is a comprehensive, practical and engineering course. It is difficult to master the technology in a limited period of time. Therefore, the theory teaching needs the strong support the experimental teaching.

Based on this, combined with the actual situation of HuBei engineering University, "DSP principle and application" experiment teaching reform has been done. The result proves that this method is success; the teaching effects are more obvious and get a high praise of other teachers in the teaching and research department.

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