Teaching Reform Practice of A SCM Course Based on Inquiry Learning: A Case Study of Digital to Analog Converter

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Abstract

The Principle and application of single chip microcomputer (SCM) is an important professional foundation course for electronic information specialty. However, with the characteristics of high practice, rapid update, highly abstract, strong logicality, etc, it seems difficult for students to study and the traditional teaching method is so boring that students have little interest in it. It explores the application of the investigative learning method in SCM course teaching in this article. It takes the section of digital to analog converter (DAC) as a case study, describes the procedure of analysis, design and programming in investigative learning teaching method. Questionnaires were administered to students of three classes, and the results show that it improve the learning interest and learning activity, cultivate the innovation consciousness and practice ability of the students, teaching effect of this method is good.

Key words: INQUIRY LEARNING, TEACHING METHOD, PROTEUS SOFTWARE, SIMULATION, TEACHING EFFECTIVENESS

1. Introduction

Principles and Applications of a Single-chip Microcomputer (SCM) is a very important specialized course to electronic information specialty, such as electronic technology, automation, electrical engineering. SCM has small, strong function, low cost, etc, it can be said that wide application, intelligent control and automatic control core is the microcontroller. At the same time, learning to use the SCM is the best choice to understand the principle and structure of computer. In addition, it is closely related to people's lives [1]. It consists of the structure of microcontroller hardware, design of software and applications.

SCM has the properties of abstract and complexity, it is hard to get started to a beginner. Students lost the confidence of the study, and chose to give it up, so as to many students cannot develop an application after graduation and some students do not even know the working process of SCM. Practical skills should be developed and cultivated for beginner students. Literatures [2-4] proposed the ideology of new teaching methods and models. Great deals of reforms have been proposed to improve the teaching effectiveness of the SCM course [5-9], but the results are often not as planned and expected.

The traditional system of education is teacher centered, with the teacher focused on giving out information about "what is known". Students are the receivers of information, and the teacher is the dispenser. Inquiry learning or Problem-based learning, as a way of learning, is a process in which the students can discover problems, inquiry them and make conclusions initiatively with the help of the teacher, it encourages students to conduct group discussions. So students are no longer the acceptor only, but become explorer, discover and processor, the role of teacher changes from one of telling students correct answers to one who is guiding and facilitating learner activity in the meantime. Its goal is to cultivate the researching and practicing ability of students [10-14].

2. Teaching procedure

Now we will take the section of Principles and the applications of DAC as a case study to introduce the inquiry learning in the application of SCM course teaching. DAC is a very important device in the SCM course. Internal structure of DAC is complex,invisible and not touch, teacher feel frustrated to explain, student feel difficult to learn at the same time. Teachers explain theory and the basic application of this component, and then students verify the program of the textbook. It is very difficult to grasp the working process of DAC for students, so the teaching effect is poor. Inquiry learning mode is used to improve the teaching process as follows.

2.1 Study content

Knowledge points of this section are shown in Table 1. It consists of basic knowledge, related knowledge and comprehensive knowledge.

Table 1. Knowledge points

Classification	Knowledge points
Basic knowledge	Definition, internal structure and working principle of the DAC
Related knowledge	PROTEUS simulation software Assembler programming
Comprehensive knowledge	The generation of waveform signal

2.2 The experiment tools

Proteus is developed by the British Lab center with circuit analysis and simulation function is the hardware simulation and debugging interface, which plays a great role in the course of SCM, it can gives students a dynamic and visible show of MCU, which makes it easy to understand and master the process between MCU and peripheral circuits [15]. Students can develop a strong feeling and understand the role and status of SCM in a complete system by the software of Proteus.

2.3 Process of Inquiry learning

Definition, internal structure and working principle of the DAC are discussed in group, and then draw circuit diagram using the soft of Proteus, The circuit consists of Minimum System of SCM, DAC and ideal operational amplifier. The output of the operational amplifier is connected to the oscilloscope, so as to observe the output waveform, the circuit diagram is shown in Figure 1.

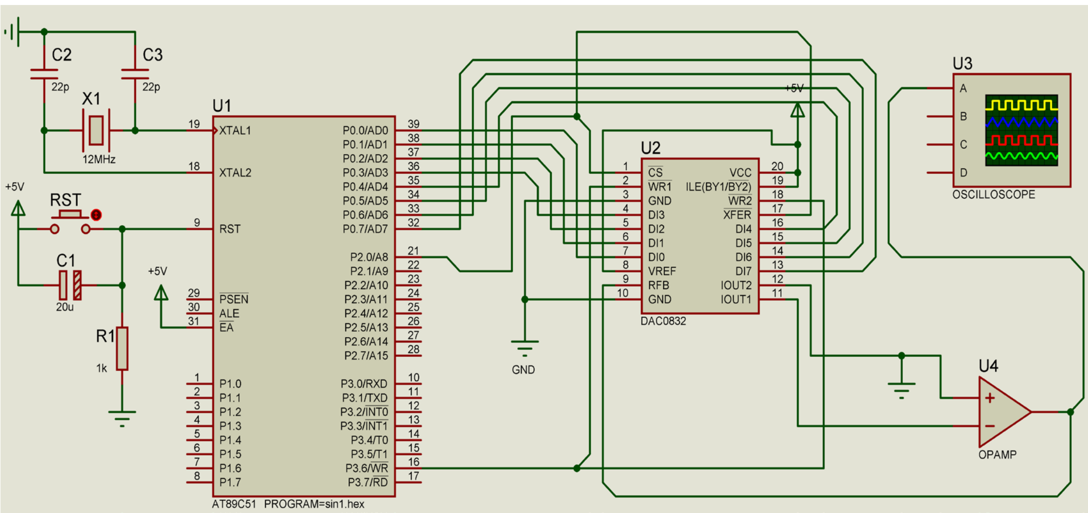

Figure 1. PROTEUS circuit diagram

Assembly program is designed according to the circuit diagram, and it controls the DAC produce sawtooth wave, the teacher can demonstrate this pro cess using the Proteus software, program and the simulation waveform is shown in Figure 2.

After the explanation, the teacher can let the students discuss why we can get the continuous waveform? Students can get the answer by changing the scan time of oscilloscope from0.5 ms/div to 5 us/div. Actually, the decline process of sawtooth wave is made up of 256 small ladders shown in Figure 3. Because the ladder is very small, it is a linear change of sawtooth in the macroscopic view.

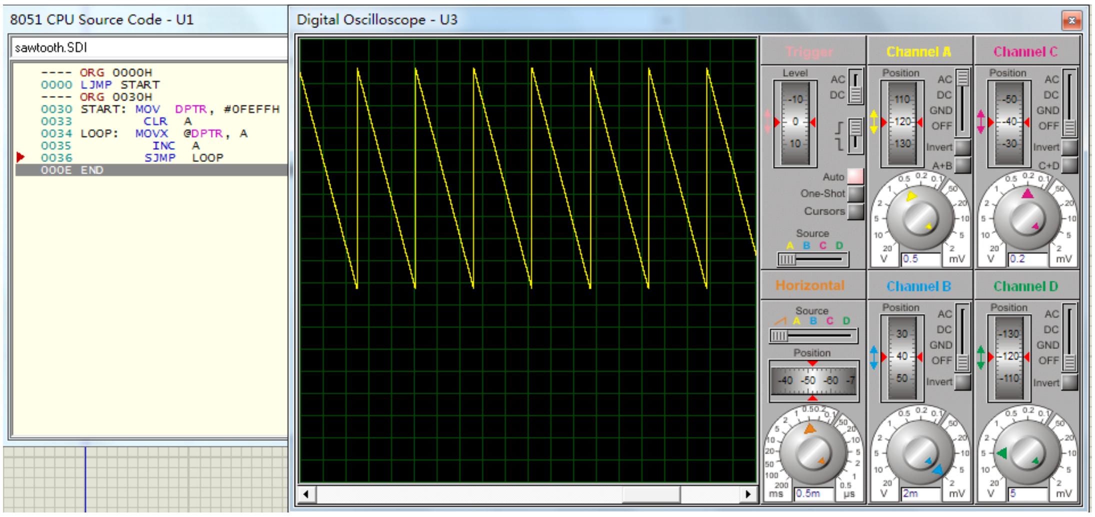

Figure 2. Program and simulation waveform of sawtooth wave with 0.5 ms/div

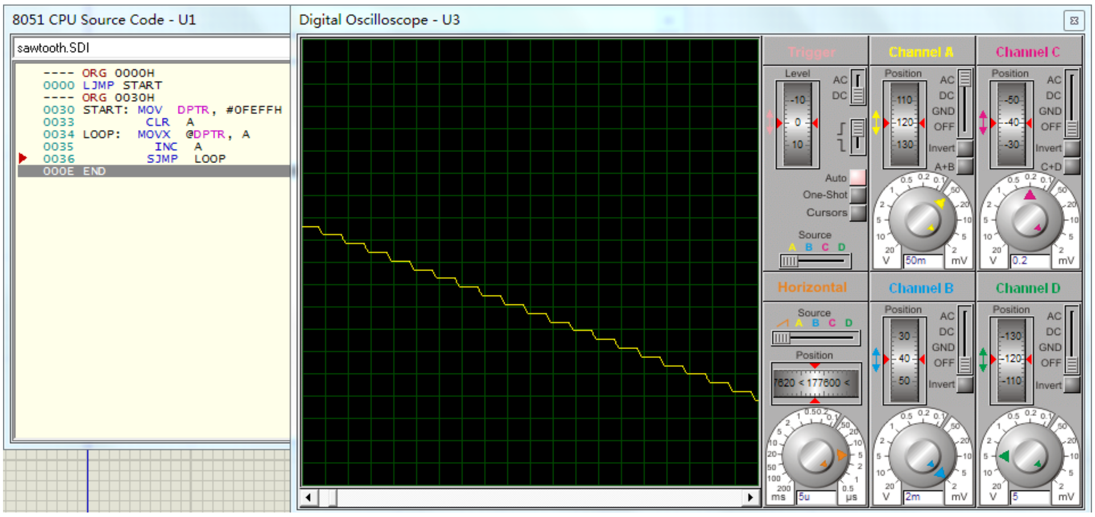

Figure 3. Program and simulation waveform of sawtooth wave with 0.5 ms/div

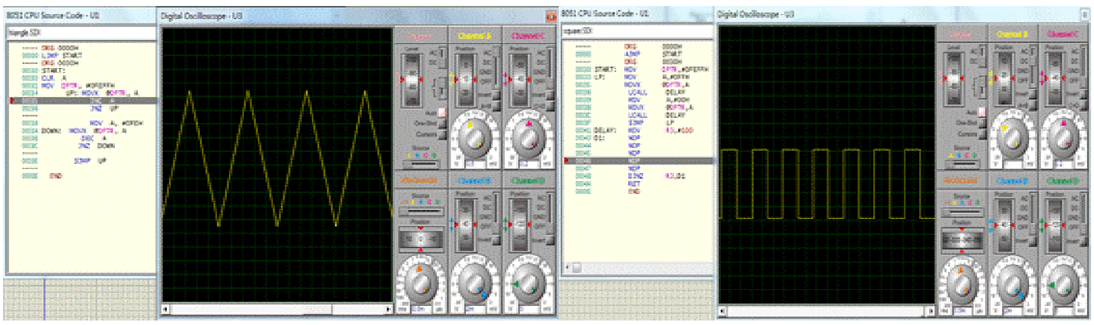

Figure 4. Program and simulation waveform of triangular wave and square wave

How we can produce the triangular wave and square wave by changing the program? When the students finish their discussion and experiments, they can get the waveform shown in Figure 4.

On the basis of the above problems, we increase the difficulty and inspire the student to obtain a rectangular wave and trapezoidal wave. It is easy to produce rectangular wave by changing the program of square wave. Students can find trapezoidal wave can be got by two kinds of waveform in Figure 4. Program and simulation waveform of rectangular wave and trapezoidal wave are shown in Figure 5.

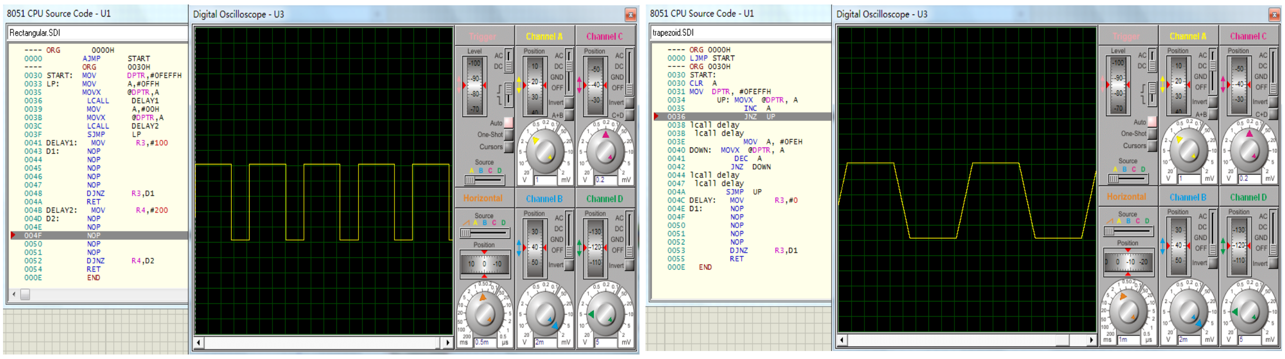

Figure 5. Program and simulation waveform of rectangular wave and trapezoidal wave

All above questions have been answered easily, then, how do we get sine wave by using SCM to control DAC? This question is not easy enough for everybody in class to answer. Only a small percentage of students can get waveform shown in Figure 6. Students consult books, magazines, websites, and then finish discussing in groups.

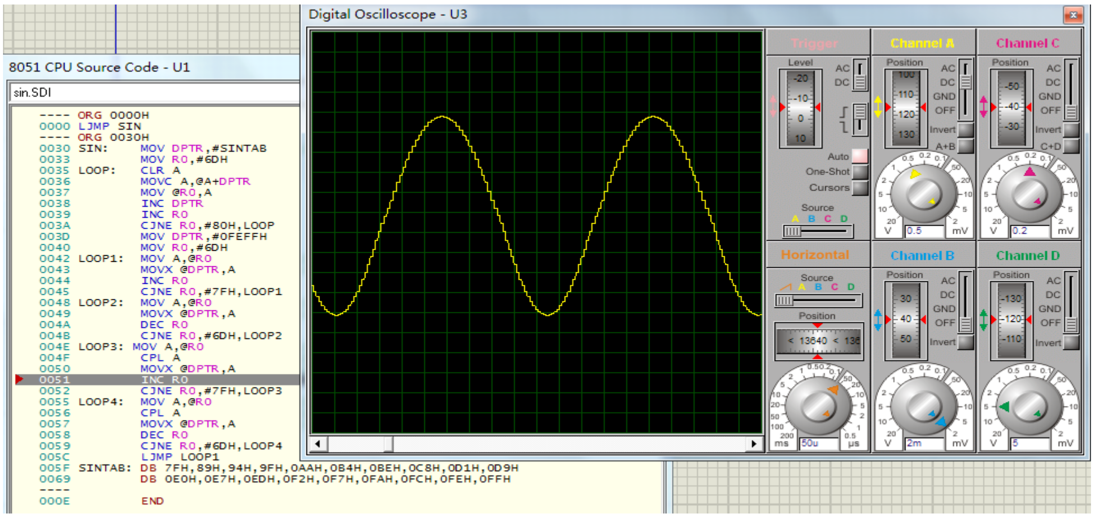

Figure 6. Program and simulation waveform of sine wave with 73 sampling points

Some students will find that the waveform of Figure 6 is not smooth. Then the new question is how do we get a smooth waveform? 73 points are sampled with equal interval in one period in Figure 6, after analysis and discussion, students increase the sampling points to 197, program and simulation waveform are shown in Figure 7.

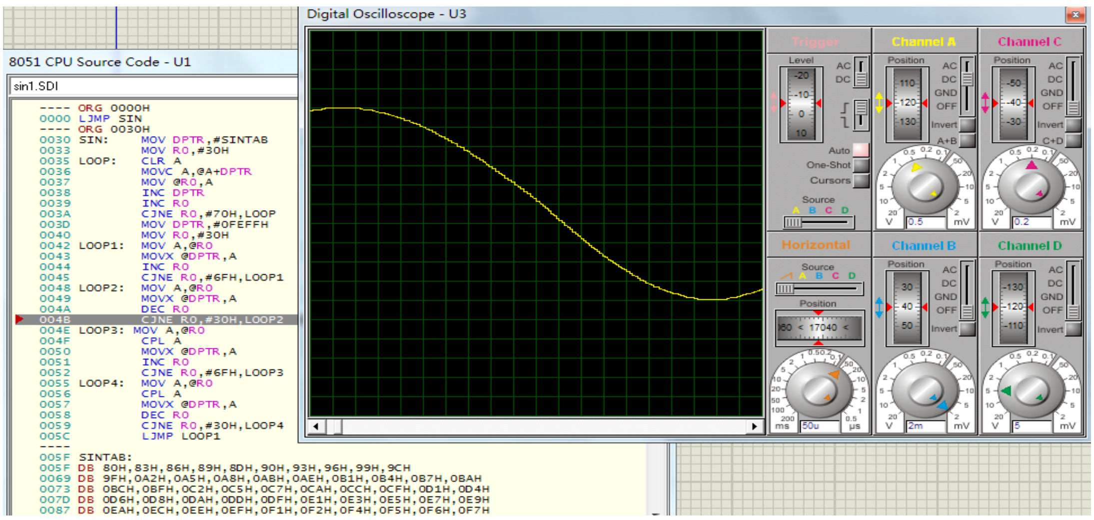

Figure 7. Program and simulation waveform with 197 sampling points

3. Discussion

a. How to determine the voltage amplitude of the output signal?

b. How to change the cycle of the output signal? How to change the duty cycle of rectangular wave?

c. How to make signal generator using the knowledge learned from this section?

4. Conclusions

This paper presents a case study based on inquiry learning, teacher transforms from the main actor and dictator to an advisor or facilitator in the classroom and the students are able to more active participation, research and study throughout this teaching process. It tries to cultivate students' ability to learn actively, to think critically and to solve problems through an instruction process that focuses on practical tasks. Teaching effect shows: It has increased a lot after adopting inquiry learning teaching mode compared with traditional teaching method. Inquiry learning can improve student's ability for finding, analyzing and solving problems. The practice of teaching proves that this method plays a good effect.

Acknowledgements

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