The Research and Practice of Teaching Method Reform for Single-chip Microcomputer Course

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Abstract. Single-chip microcomputer has played an important role in the field of computer control science and technology. With the rapid progress in semi-conductor, there are also new relative advances in microcomputer science and technology. How to design single-chip microcomputer course becomes more challengeable than before. In this paper, we analyze the problems of present single-chip microcomputer teaching and describe the innovations and reformations in the teaching methods of the single-chip microcomputer course based on our background of our many years' teaching and research. The paper presents the principle of case choosing in the case teaching process, along with the basic methods of case design and teaching procedure scheduling. Through the simulation in Proteus soft and project designing & making, students master the basic knowledge and designing method. The method greatly improves the students' learning enthusiasm and better cultivates the students' MCU comprehensive application ability.

Keywords: Proteus, Single-chip microcomputer, teaching method; case driven teaching

1. Introduction

Single-chip microcomputer is the fundamental course of electric and information major and related computer science major. It is also the core course for the students to master the basic principles of computer system design. The fast development of single-chip microcomputer is the challenge to this course. The key goals of this course are how to instruct the students to learn the basic theories well and how to cultivate the students' investigative spirit and how to waken the students' innovative potential. Our teaching group tries to explore in this space. Single-chip microcomputer is a highly practical course, including lots of experiments and practices. It plays an important role in training the students' experimental and innovative thinking abilities. At present, most of the colleges and universities are using hardware experiment equipments in their laboratories. Because of its high price and the limitation of the chips on the experimental board, it has limited students' innovative idea, and also cannot fit the current popular technology and meet the students' needs of independent design. By employing the Proteus software and case driven teaching method in single-chip microcomputer teaching, we can fully mobilize the students' enthusiasm, and therefore improve the teaching effect and the teaching quality.

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The paper is organized as follows. Section 2 describes the hands-on labs environment. Section 3 depicts the construction of experiment platform. Section 4 describes the innovations and reformations in this course. Section 5 shows a teaching case. Section 6 offers the conclusions and future work.

2. Hands-on Lab Environment

Hands-on labs are very important in single-chip microcomputer course. The students should also learn how to design and implement a whole computer system through practice based on the basic principles. We have design the basic hands-on labs according to the teaching contents. The purpose of the hands-on labs is to assist a 5-day course that teaches single-chip microcomputer programming concepts, programming skills and hardware system design. The purpose of every lab is to reinforce one or several single-chip microcomputer programming skills and concepts. In order to cater to students with different levels of understanding of single-chip microcomputer system design, we provide 9 handson labs from basic programming know-how to system design. Here is the table of contents of the labs.

Lab 0: Environment Setup and make the first program

Lab 1.1: LED lamp driver control

Lab 1.2: Eight LED lamps driver control

Lab 1.3: Eight LED lamps control with interrupt

Lab 1.4: Eight LED lamps control with timer

Lab 1.5: Eight LED lamps control with interrupt, timer, time display and time adjusting

Lab 1.6: Two computers serial communication

Lab 2.1: Design of digital clock

Lab 2.2: Design of traffic light control system

Lab 0 is for the first hands-on lab section. In this lab the students will learn: how to build connection with PC, such as, downloading work flow ,hardware debug skills. How to operate Keil C IDE, which include Keil C install, create a project, software work flow, light one led, create hex file, etc.

Labs 1.1 to 1.6 are for the second lab section. In these labs the students will learn: how to detect key, how to light led lamps, how to control interrupter, timer, and UART.

Lab 2.1 and 2.2 are for the third lab section, which are comprehensive application experiments. Most labs are designed with levels of different difficulties. Due to limited time in a hands-on lab section, we ask you that you choose the difficulty level that best fits your programming skills. If you have time, you can take on another level.

3. Construction of Experiment Platform

Experiment platform include hardware construction and virtual experiment platform. The single-chip micro-computer virtual experiment platform uses Proteus and KEIL development tools. The virtual experimental platform framework is shown in Figure 1. We use Proteus to design simulation circuit and use Keil development tools to write programs.
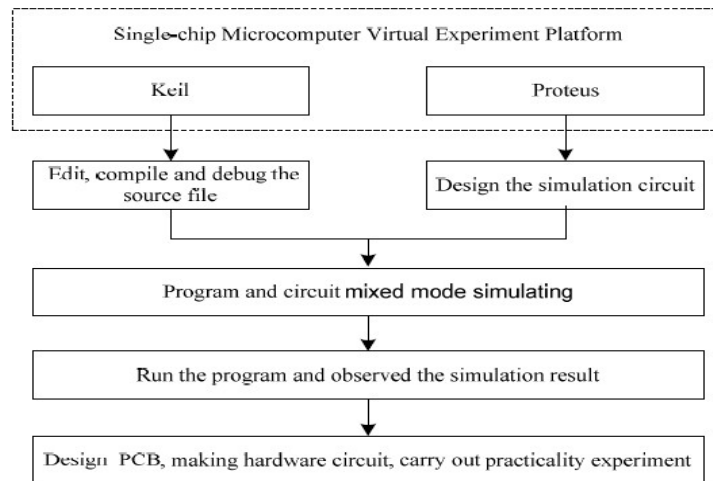
Figure 1. Framework of Single-chip computer virtual experiment platform

Keil development tools support every level of software developer from the professional applications engineer to the student just learning about embedded software development. When starting a new project, simply select the microcontroller you use from the Device Database and the μVision IDE sets all compiler, assembler, linker, and memory options for you. Numerous example programs are included to help you get started with the most popular embedded 8051 devices. The Keil μVision Debugger accurately simulates on-chip peripherals (I²C, CAN, UART, SPI, Interrupts, I/O Ports, A/D Converter, D/A Converter, and PWM Modules) of your 8051 device. Simulation helps you understand hardware configurations and avoids time wasted on setup problems. Teachers can design the simulation experiment system according to the experiments teaching requirement, such as LED display, timer and interrupter application, the key operate, dsl302 application, etc.. Through the virtual experiment, students can better apply theory to practice, master the programming techniques, familiar with the hardware circuit. After class, students can also use virtual laboratory study and design MCU system.

4. Reformation in Advanced Teaching Methods

Teaching methods which our group adopted focus on the emerged problems both in teaching and feedbacks from the students. The improved teaching effects rely on not only the teaching but also the learning. The learning confidence and inspired motivation of the students will play an important role in the teaching and learning. We have tried to research the following areas.

4.1. Heuristic Teaching Method

Based on the experience in teaching single-chip microcomputer, we use heuristic teaching method in our course. Through such method, the students will be inspired to think "why" and "how" in single-chip micro-computer programming and hardware designing. They will not only receive the knowledge from the teachers and the textbooks passively, but also try to understand the principles on their own initiatives. The teachers will provide the questions and try to lead the students in thinking. The students can have their own designs even if some of these designs were wrong. But the answers will correct the errors. And sometimes the students will also have some interesting solutions.

4.2. Case-Driven Teaching Method

Designing some operable cases for the practice can inspire the students to learn in great passions. It can also cultivate the students' ability of analyzing and solving the problems, and train the students' skills in researching and practice. These cases provided to the students will be divided into different levels according to the difficulties. The different levels will help the students in gradual progress.

4.3. Teaching Method Based On Problems

The students are organized as different groups according to their own wills. Each group has two to four students. The teachers will provide many topics. Each group can select one topic as their problem or design their own topic. The main challenge for each group is to analyze the topic, search and acquire the correlative

information around the problem need to solve. Each group should have the sure technology route and implementation schema and dispatch the detail tasks to each member in this group to cooperate on this problem. And at last they have to solve the problem and submit their solutions. The whole process is finished by students completely while the teachers only offer some necessary tutorship. Such practice based on problems could increase the students' interests to the course, cultivate their ability of exploration and innovation and boost their cooperative consciousness and spirit. It is good for their further learning and work in the future.

4.4. Task-Driven Teaching Method

The teachers could organize teaching contents as some special tasks and dispatch them to the students. The main target of task-driven teaching method is to train the selflearning ability. During the process, the teachers would provide some examples to the students to give themconfidence that they can finish the task after learning. This step is very important, for it may eliminate the students' feeling of fear to complete tasks in time. The keystone of task-driven teaching method is how to implement the teaching goal during self-learning and collaboration learning. Self-learning is around the students to complete the tasks by their own after their searching for useful information. The students are required to exert initiative during the learning. The students can obtain different ideas and approaches from the others. Collaborative learning is based on self-learning, and it may improve the learning effects through the discussions.

5. Analysis of Teaching Cases

5.1. Eight LED Lamps Driver Control

The objective of this lab is to design a LED lamps control system using single-chip microcomputer AT89S52. It can switch on all the LED lamps sequentially.

5.2. System Design And Simulation

According to the knowledge they learned, the students select the devices and design the system in Proteus ISIS. The schematic circuit of second timer system in Proteus is shown in Figure 1. The system includes AT89S52, crystal oscillator circuit, reset circuit and LED lamps driver circuit. The electronic components used in the system are shown in Table 1.
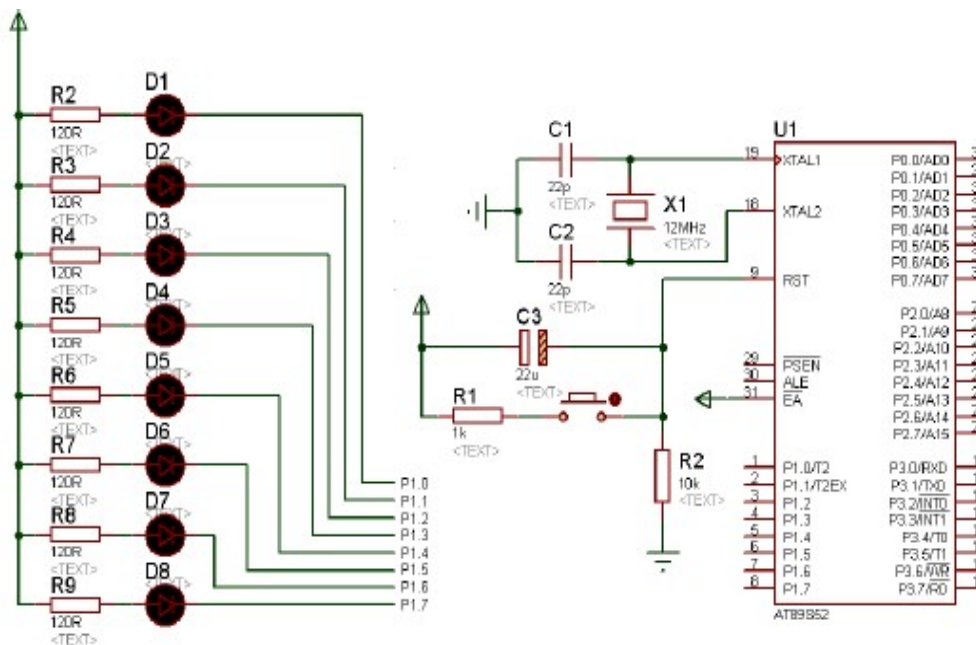

Figure 2. Schematic circuit of second timer

SN	device	category	Description
1	AT89S52	Microprocessor ICs	AT89S52
2	LED	optoelectronics	LED-green
3	AVX0402NPO22P	capacitors	22p
4	AX22U50V	capacitors	10uF/50V
5	BUTTON	Switches & relays	button
6	CRYSTAL	miscellaneous	12M
7	MINRES1K	Resistors	1k
8	MINRES10K	Resistors	10k
9	MINRES120R	Resistors	120R

Students can create a new project using the Keil development tools. Program can be written in assembly or C language. Edit the source program (C or ASM), build project and create a HEX file. Load the hex file to CPU in Proteus. Running and debugging program in Keil while observe the operating results in Proteus.

5.3. Practical Electronics/PCB Manufacture

After simulation, the students need to carry out practicality experiment which include design the circuit, select the electronic components and weld. Hands-on techniques learned for project planning, soldering, and hand tool usage and production methods. The product made by student is shown in Fig.3.
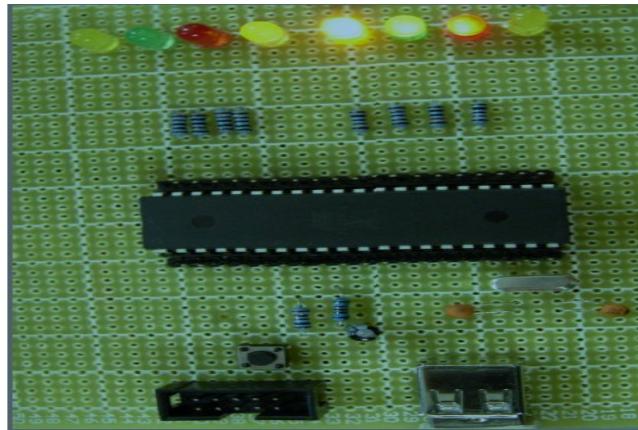

Figure 3 Product of student

6.Conclusion

In this paper, we present our innovations and reformations in teaching methods of Single-chip microcomputer course at Henan Polytechnic University. These innovations and reformations are based on the background of our teaching and research in related fields. The teaching effects show that the proposed reformations are effective in teaching. During the teaching work, there are also some problems, which should be solved. These are our future work.

7. Reference

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