Application of Proteus and Keil Software in the Teaching of MCU Course

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Abstract: According to the teaching characteristic of MCU course, the application of Proteus and Keil Software in the teaching of MCU course is elaborated with a concrete example. By using this teaching mode, it can organically combine the theory teaching and practice teaching, better stimulate the students' learning interest, improve the students' learning initiative and enthusiasm, and cultivate the students' comprehensive quality such as engineering practice ability and innovation ability.

Introduction

MCU course has two properties. First of all, MCU course is a basic professional course, which focuses on the working principle and process of microcomputer. It can help the students understand the basic concept of the microcomputer, and also provides the theoretical basis for the further specialty study. Secondly, MCU is a practical engineering technology in the electronic field, which focuses on teaching students how to design an electronic system with MCU. It can provide a basic foundation for the future engineering work.

MCU course has many concepts, complicate contents and strong logic. It includes both the hardware design and software design. Traditional MCU course experiment is completed by using the hardware experiment devices, which has the disadvantages such as the relatively fixed experimental contents, the poor flexibility, the high investment and maintenance costs, so that the students’ innovation and creative thinking cannot be reflected. In order to break the restrictions of current teaching of MCU course, Proteus and Keil software should be applied in the experimental teaching. By using Proteus and Keil software to complete the simulation and programming, it has more flexibility in designing experiments, easier to extend the experimental items. Thus it can fully mobilize the students’ enthusiasm to learn MCU course and improve the teaching effect [1].

Advantages of Proteus and Keil software in the teaching of MCU Course

Proteus is EDA tool software developed by the British company LabCenter Electronics. It not only has simulation capabilities of other EDA tool software, but also can simulate the MCU and other peripheral devices. Proteus has a powerful capacity of designing MCU diagrams, realizing the real-time interactive simulation of the circuits, and providing a variety of virtual instruments for the designers, so it is currently the best simulation tool of MCU peripheral devices [2].

Keil C51 is a C language software development system for 8051 series MCU, which is produced by Keil Software company, is one of the world's best 51 MCU development tools. The object code generated by Keil C51 has high efficiency and compact code, easy to understand, which can reflect more advantages of advanced languages in the development of large-scale software. Compared with the assembly language, C51 also have obvious advantages in function, structure, readability and maintainability, which is easy for students to learn [3].

By using Proteus and Keil software, it not only can truly demonstrate the process and phenomenon of MCU, and also can provide students with a strong cognitive platform. The teaching of the course is no longer limited by the conditions, time and place of the laboratory. Only with the computer, students can carry on the simulation experiment. Thus it can improve the students' learning autonomy and flexibility. By using the simulation operation, it eliminates the circuit trouble and error caused by
welding reason. As long as the circuit hardware design and software programming are right, the student can get the result, and then they will have a sense of achievement, so as to improve the learning interest. During the teaching process, the teacher can more flexibly construct and design virtual hardware system with the engineering application. As the simulation results are showed immediately and visualized, it can enhance the students' perceptual knowledge, so as to further stimulate the students’ initiative and creativity [4].

Teaching Application Examples
The MCU system development by using Proetus and Kei software mainly includes three steps. Firstly, the diagram circuit is designed in Proteus software, and the program editing and debugging are completed in Keil software. Secondly, the co-simulation debugging is fulfilled combining Proteus with Keil software. Finally, after the successful completion of system simulation, the student can make the real product, so as to further certify the simulation results of the system.

The example is the design of microcontroller based thermometer, the specific requirements are as follows. Firstly, the temperature measurement range of between 0℃ and 50℃; Secondly, the temperature measurement error is less than 1℃; Thirdly, the system can display the current temperature and current time. Finally, the system can set the temperature alarm range, if the temperature is out of range, the LED will be lighted.

According to the design requirements, the principle diagram of the system is determined, as shown in Fig. 1. The system consists of AT89C51 microcontroller, oscillation circuit, reset circuit, four keys, one LED, temperature sensor DS18B20 and display module LCD1602.

Temperature sensor DS18B20 is a 1-wire bus digital temperature sensor. It has only three pins, which are VCC, GND and DQ. It operates on an external power supply mode, where DQ is directly connected to P3.7 of the microcontroller, and connected to VCC through the 4.7K pull-up resistor [5]. Display module LCD1602 can display two rows of information at the same time, and 16 characters per row. The data pins D0 ~ D7 of LCD1602 are connected with the P0 of AT89C51 to realize data transmission. The control terminals of RS, R/W, E are respectively connected to P2.0, P2.1, P2.2 of AT89C51 to achieve functional control.

The software programming interface in Keil is shown in Fig. 2. The software is a modular structure, which is written in C51 language.
The software consists of the main program, key subroutine, temperature acquisition subroutine, display subroutine, T0 interrupt subroutine and so on. The flow chart of the main program is shown in Fig. 3. At the beginning of the main program, it calls the initialization subroutine, temperature acquisition subroutine, display subroutine and the key subroutine, and then determines whether the current temperature exceeds the upper limit value. If the key K0 is pressed, then the hour, minute, second and temperature upper limit can be set separately. If the key K1 is pressed, then the corresponding data will be incremented. If the key K2 is pressed, then the corresponding data will be decremented. If the key K3 is pressed, then the temperature control switch is turned on.

After the success of the simulation debugging, the produced thermometer is shown in Fig. 4. The current time, temperature upper limit value and current temperature data are displayed on the LCD 1602 screen. As the current temperature exceeds the upper limit value, the blue LED is on.
Figure 4. Produced Thermometer.

Conclusions
In summary, carrying on the teaching of MCU course by using Proteus and Keil software can combine the theory teaching and the practice teaching organically, improve the teaching efficiency and the quality, and obtain better teaching effect. The students can make the product after the success of the simulation, so that they learn the design and debugging process of the whole MCU application system. This teaching mode can better stimulate the students’ interest in learning, improve the student’s learning initiative and enthusiasm, cultivate the comprehensive quality such as engineering practice ability and innovation ability.

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References