Design of Experimental Simulation of Computer Science and Technology Specialty Under Background of "Emerging Engineering Education"

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ABSTRACT
To cultivate the practical needs of cultivating the compound engineering talents of computer science and technology under the background of "emerging engineering education", this paper starts from the characteristics of computer science and technology, taking the course of sensor technology as an example. Firstly, it analyzes the characteristics of the course and the problems in practical teaching and then proposes a project-driven experimental teaching method based on the joint debugging of Proteus and Keil. Finally, using the electronic scale system as a simulation experiment case, the main process of the course experiment using Proteus and Keil joint debugging is summarized through the case. It aims to strengthen students' understanding of core knowledge and cultivate practical engineering ability.
Keywords: *experimental teaching, proteus, emerging engineering education, project-driven approach*

1. INTRODUCTION

Experimental teaching is an important part of the higher education system and an important teaching method for the cultivation of innovative compound talents[1]. Compared with theoretical teaching, it is more intuitive, practical, comprehensive, exploratory, and enlightening, and it is not only useful for improving the comprehensive quality of students but also the practical ability and innovation ability play a vital role[2]. Sensor technology is an important professional course that is offered in the direction of computer science and technology. This course mainly cultivates students' ability to recognize, detect, analyze and apply sensors. The theoretical knowledge of this course is obscure, abstract, and difficult to understand. The traditional sensor application technology course teaching mainly has the following problems: firstly, separation of theoretical knowledge and experiment. Secondly, the traditional experiment box is used for unified teaching, and the sensor modules cannot be chosen at will. Students can only conduct step-by-step experiments based on the functional modules of the experiment box. It is difficult to cultivate students' innovation and creativity. Finally, during the experiment, students plug in the sensor module used according to the experimental guidance steps and turn on the switch of the experiment box to observe the corresponding experimental phenomenon, which makes it impossible to cultivate the ability of software and hardware joint debugging in the experiment. Based on the above situation, this article proposes a method of using proteus and Keil to jointly debug and design experimental cases. Through reforming the assessment plan, the starting point is to cultivate student's ability to combine theory and practice in engineering practice, and hope to enhance students' enthusiasm for learning and stimulate students to solve problems.

2. EXPERIMENTAL FACILITY

Proteus is an EDA simulation tool that can complete from a schematic layout, code debugging to MCU peripheral circuit co-simulation[3]. The tool supports multiple processors and supports multiple compilers such as IAR, Keil and MATLAB[4]. In experimental teaching, the use of proteus and Keil collaborative design can facilitate and flexibly modify the MCU and sensor modules. At the same time, the project can be simulated in real-time through Keil programming, which can easily carry out large-scale integration and design that cannot be carried out by traditional experimental boxes. The experimental project reduces the construction and subsequent maintenance costs of the laboratory to a certain extent. At the same time, you can see the simulation results of the experimental project in real-time, which can further stimulate the students' enthusiasm for learning[5]. Keil is an integrated development environment (uVision) compatible with C language software development for single-chip microcomputers produced by Keil Software in the United States[6]. The joint debugging block diagram of Proteus and Keil is shown in Fig. 1.

During joint debugging, firstly, select the MCU model in Keil, which is the same as the circuit drawn by proteus, then write the C program, compile and generate the HEX file, then click the DSN file in proteus, and open the schematic circuit diagram, which is designed by proteus.

Finally, click the MCU in the schematic diagram and select the corresponding hex file, as shown in Fig. 2.

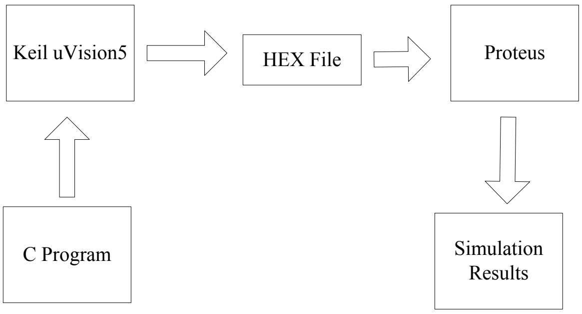

Figure 1. Block diagram of joint debugging of proteus and Keil.

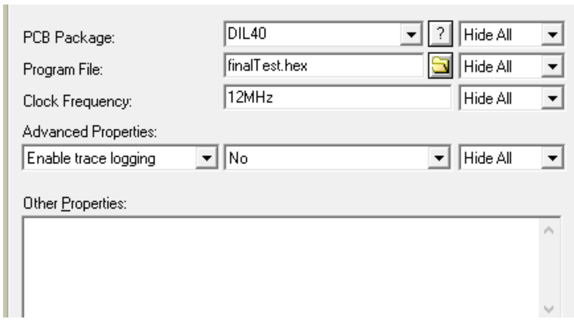

Figure 2. HEX file selection block diagram

3. EXPERIMENTAL TEACHING CASE

In this experimental teaching case, an electronic scale based on MPX4115 is designed. By using the characteristics of the pressure sensor, the collected signal is first converted into a digital signal by the LTC1297 digital-to-analog converter and sent to the MCU, and then processed by the MCU and displayed to the LCD. Finally, enter the unit price amount through the small keyboard, and click the equal sign on the keyboard to display the total price of the goods on the LCD screen.

3.1. Function Analysis of Experimental Case

This case requires students to apply the relevant knowledge of the pressure sensor to comprehensively develop and implement system functions. Firstly, the functional requirements of the system are reasonably decomposed and divided into several sub-modules. The hardware circuit is implemented on Proteus, and then the driving mode and signal transmission mode of each hardware circuit is analyzed. Finally, the driver of each hardware circuit is designed in Keil.

The system needs to perform weighing and pricing. The core is to collect the signal through the pressure sensor and transmit it to the MCU. Firstly, enter the unit price through the keyboard and transmit it to the MCU, and then display it on the display screen after comprehensive processing by the MCU. Therefore, the system is composed of 5 major modules, which are respectively controlled as shown in Fig. 3.

In this case, an 8-bit MCU from Atmel is used as the controller, and mpx4115 is used as a pressure sensor to convert the weight of the cargo into an electrical signal. Then the signal is converted into a digital signal through the LTC1297 and sent to the MCU for processing. Enter the unit price of the item through the keyboard, and then press the equal sign key to display the total price of the item on the LCD. The students were more interested in the implementation of the experimental simulation case. The case applied the pressure sensor knowledge learned in the sensor course. Through the implementation of the case, the theoretical knowledge was applied to real life, so that students could truly feel that what they learned was applied. Through this experimental case, the students' ability to "combine theory and practice" has been cultivated.

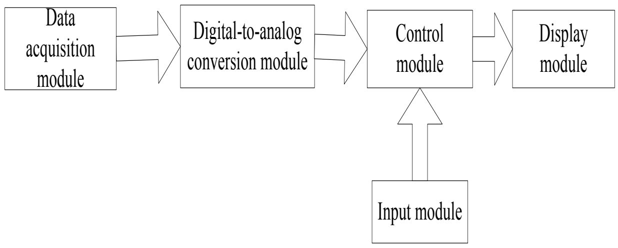

Figure 3. System model diagram

3.2. Hardware Module Design

The system module of the experimental case is shown in Fig. 3. Students can select components in the component library on the proteus simulation software during the decomposition of the experimental case. The system hardware circuit diagram of this case is shown in Fig. 4, and the simulation results are shown in Fig. 5 and Fig. 6.

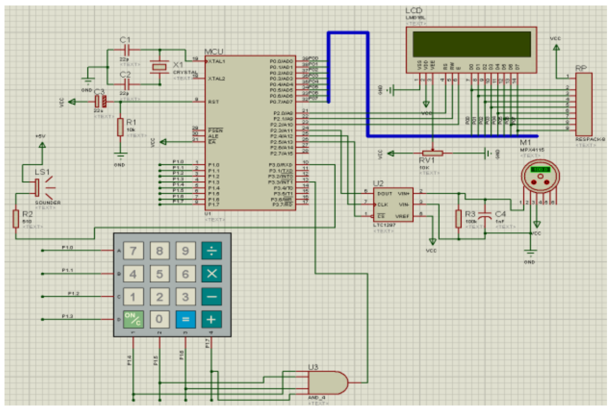

Figure 4. Hardware circuit diagram

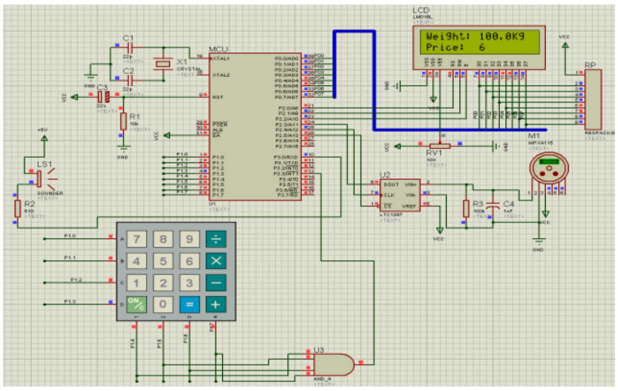

Figure 5. Simulation result 1

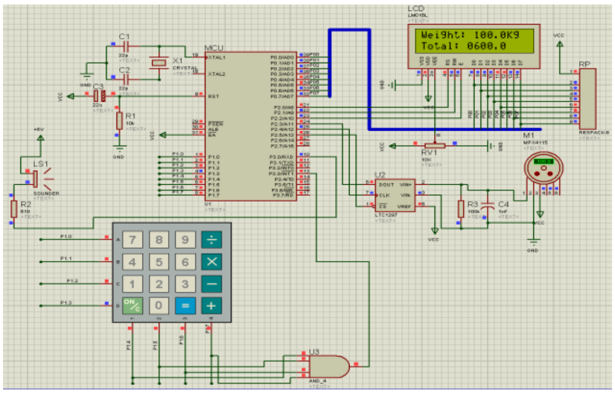

Figure 6. Simulation result 2

The system is designed with the smallest MCU system. The crystal oscillator is connected with two 22pf capacitors for frequency matching to achieve the purpose of correcting the frequency of the crystal oscillator. An external resistor is connected to the LCD data line. Its function is to filter and prevent static electricity. The connection between the display module and the MCU adopts a bus structure and a network label method. The first pin of the MPX4115 is connected with a resistance-capacitance element for signal filtering. Fig. 5 shows that the weight displayed on the LCD is 100 consistent with the data collected in mpx4115, and the price input is 6. The total value displayed in Fig. 6 is 600, and the result is exactly the weight multiplied by the price, and that is the total price of the item.

3.3. Software Module Design

The software module is shown in Fig. 7 and 8. The program in this case is written in C language. Because Proteus itself cannot be compiled and debugged, this experimental case uses the joint debugging method of Keil and proteus. The C program is developed in the Keil uVision integrated development environment, and the final compiled hex file is "downloaded" to the MCU. The software part of this experimental case must first be decomposed into software sub-modules according to the hardware modules, and then the overall flow chart must be designed, then the subroutines of each module must be written according to the divided sub-modules, and finally integrated into the main function. The software of the case can be divided into two major parts: one part is the system initialization operation, and the other part is the operation of data collection, processing, and display.

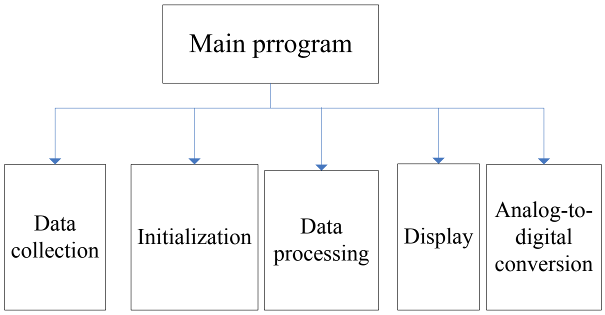

Figure 7. Main program diagram

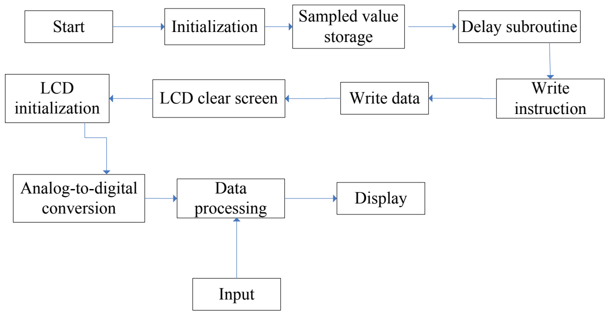

Figure 8. Program flow chart

4. TEACHING IMPLEMENTATION

The experimental teaching case is a comprehensive application of sensor technology, electronic technology, and programming technology to solve practical problems in life. Therefore, in the teaching process, the teacher must decompose the comprehensive project, and at the same time allocate the corresponding experimental hours to each sub-module, and finally integrate the various sub-modules.

4.1. Decomposition of Experimental Tasks and Assessment

This experimental case is a comprehensive experiment. According to the situation of our students, the project can be designed to be 12 periods. The allocation of period and the evaluation are shown in Table 1 and Table 2. During the implementation of the experiment, the main difficulty is data collection and storage. Most students have more problems with the implementation of sampled value storage code. Since the analog-to-digital converter in this case uses the LTC1297 module, which uses a differential mode, there are certain difficulties in programming. To enable most students to complete the task and achieve the teaching goal in the code implementation process. Before the subtask module is carried out, first send the LTC1297 chip manual to the students for learning, focusing on the working principle and working methods, and then send the application case code of the chip in other projects to the students for self-study.

Table 1. Task decompose table

Subtask Module	**Class Hours Allocation and Assessment Content**	
	Class hours allocation	***Assessment content***
Task 1: data acquisition and sampling value storage module	1	Hardware circuit design
Task 2: analog-to-digital conversion module	1	
Task 3: input and display module	1	
Task 4: data processing module	1	
Task 5: data acquisition and sampling value storage module	1	Software programming
Task 6: analog-to-digital conversion module	1	
Task 7: input and display module	1	
Task 8: data processing module	1	
Task 9: System debugging and operation	1	Software and hardware joint debugging
Task 10: project demonstration and defense	3	Project defense

When students use Proteus to design the system hardware circuit, they are required to study the data manuals and recommended reference circuits of several chips such as 1206A, AT89C51, LTC1297, MPX4115, etc. in advance. So that students can comprehensively use the I/O pins of the single-chip microcomputer for control and data transmission. The students in our college have the basis for project development using single-chip microcomputers and their peripheral circuits. Therefore, at the level of system hardware circuit design, they only need to further study the recommended reference circuits in the relevant chip data manuals. During the debugging process, students may encounter that the LCD screen does not display content. At this time, students need to check in the hardware and program whether there is a connection error and the code port definition error according to the definition of each data pin in the 1602A user manual.

Table 2. Evaluation table

Assessment Content	**Standards and Points**	
	Evaluation criteria and score (100 points)	***Achievement standards***
Hardware circuit design	1.Use Proteus to draw the correct hardware circuit.	10 points for completing item 1, 5 points for item 2 and 5 points for item 3, and 10 points for item 4, 30 points in total
	2. The module layout is reasonable, and the connection is not bent.	
	3. The names and values of pins and components are clearly and correctly marked.	
	4. The schematic can be simulated correctly.	
Software programming	1. The program has no grammatical errors.	10 points for completing item 1, 5 points for item 2, 5 points for item 3, 5 points for item 4, and 5 points for item 5, 30 points in total
	2. The program logic is clear and there is no ambiguity.	
	3. The program is highly readable and the comments are clear and easy to understand.	
	4.Convenient for secondary development and maintenance of the program.	
	5. The program adopts a structured design concept.	
Software and hardware joint debugging	1.The system can run and display.	10 points for completing item 1, 10 points for item 2, 20 points in total
	2.The operation is correct and the display is clear.	
Project defense	1. The project is clearly explained.	10 points for completing item 1, 5 points for item 2, 5 points for item 3, 20 points in total
	2.Students can answer the teacher's questions correctly.	
	3.Students have new insights and innovative ideas on the project	

This case is a comprehensive design experiment, so the experimental results of the project can be comprehensively evaluated from the four levels of software, hardware, system operation, and project defense. To a certain extent, this evaluation method avoids the problem of a single grade composition method. At the same time, it can comprehensively evaluate students from the dimensions of knowledge, skills, attitudes, emotions and values. Teachers can fully grasp the students' understanding of the involved knowledge.

4.2. Experimental Effect

The joint debugging method of Keil and Proteus has been applied in the experimental courses, and it has been conducted for 3 sessions in the computer science and technology major of our college. his model has now begun to be extended to the experimental teaching of courses such as the principle and application of single-chip microcomputers in our college. A comprehensive evaluation of multiple aspects, this model has achieved good results, saving laboratory construction and maintenance costs to a certain extent, and at the same time achieving the same teaching effect. Students apply theoretical knowledge through project cases to lay the foundation for subsequent learning. At the same time, outstanding students in the course were selected to participate in the "Sichuan University Student Robot Competition", "National College Student Engineering Training Comprehensive Ability Competition" and other discipline competitions, and achieved good results in 2018, 2019 and 2020.

5. CONCLUSION

The project-based experimental teaching model based on the joint debugging of Keil and Proteus has been applied in many courses of computer science and technology in our college. The current situation is good, and all the applied courses have achieved good experimental results. This project-driven simulation teaching mode is adopted in the experiment link of the course, which is more flexible and convenient than the traditional teaching mode of experimenting with a fixed experiment box. At the same time, the experimental projects are more diversified, and comprehensive and design experimental projects can be carried out with less investment in experimental equipment. Combined with the flexible evaluation system of experimental projects, students have cultivated the innovative practical ability to combine theory and practice, and achieved good teaching effects in the experimental link.

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