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Analysis of the Design Status of Experimental Teaching of Wireless Communication

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Abstract

Experimental teaching is a very important course in science and technology colleges and universities. With the development of science and technology and the update of education concept, how to make experimental teaching better combine theory and practice, create a new teaching mode, build a first-class practice base, and comprehensively improve the comprehensive level and sustainable development of experimental teaching in colleges and universities is a problem worthy of research and urgent solution. This paper takes advantage of the low power consumption of microprocessors, high cost performance, support for a variety of interfaces, support for a variety of embedded operating systems and other advantages to build a microprocessor as the core of the embedded development platform. At the same time, the configuration and debugging of the entire experimental platform hardware is completed. So that the set of experimental system has the advantages of high cost performance, easy maintenance, easy to upgrade and expand, to undertake a wide range of test projects. It not only meets the strict requirements of the hardware platform for open experiments at this stage, but also keeps pace with the development of electronic technology and continues to play a role in the future when the open experimental projects are increasing and the hardware requirements are getting higher and higher. Based on this experimental hardware platform, this study gives the experimental purpose, functional requirements and relevant theoretical knowledge while proposing a set of experimental design plans from the overall design of the experimental project to the specific implementation methods and conclusions as a reference implementation plan for the open experimental project. The above experimental project is oriented to market demand, based on information integration, and integrates various aspects of innovation development, plan formulation and process design into experimental teaching, which improves the comprehensive integration level of experimental teaching. The experimental projects are designed with a combination of units and systems, progressive and hierarchical. Its open experimental format can stimulate the enthusiasm of experimental participants, leave room for play and innovation, and improve their technical skills while cultivating project management and organizational skills. In the context of integrated product and process development (a new R&D management model of common interest in high-tech industries at home and abroad), it is of positive significance to broaden the horizons of experimental teaching by absorbing the market-oriented and team-oriented concepts.

Keywords

Open experiment; Embedded system; Experimental teaching.

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1. Background

With the rapid development of science and technology, computers and their related technologies have been further developed, computing will no longer be limited to the traditional PC and server environment, network computing and mobile computing will soon become a part of people's daily life, and gradually present the Pervasive Computing mode. As the support technology of pervasive computing, embedded real-time system is gradually applied to more and more fields, including intelligent process control, aerospace, transportation, flight control, communication, multimedia, office automation, real-time simulation, virtual reality, medical electronics, military electronics, information appliances and other fields. And in the university campus, although the embedded system course is offered but the embedded system combined with wireless communication student experiment projects are few. Based on this consideration, we hope to develop a student experiment project involving both embedded system and embedded operating system and wireless communication technology, and the three are intertwined, which also caters to the current trend of electronic technology development. Students can have a deeper understanding of these three areas of knowledge in the experiments and be consistent with each other, and improve their practical and hands-on skills.

2. Experimental Environment Analysis

2.1. Embedded Wireless Communication Experimental System

Usually the embedded system is mainly composed of the host (PC), and the target board. As the system needs GPRS to achieve access to the mobile network, it is mainly composed of three parts

(1) PC: as the entire experimental system of the control terminal. Receive command line input, output the information printed by the experimental system: such as the hardware information of the experimental system, information on the success or failure of the operation, SMS content, etc.

(2) Embedded system development board: running applications under the uClinux operating system. Is the main body of the program execution, according to the input command line to complete the relevant operations. Such as: data exchange and processing with GPRS terminal and PC host.

(3) GPRS terminal: The final executor of the command input from the host computer. Through the external antenna to complete the mobile network access, SMS sending and receiving, voice calls and other functions. Use RS232 interface to connect with the experimental development board, and use it to complete data exchange.

Figure 1. Experiment box used in the communication experiment course

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3. Wireless Communication Experimental Course

3.1. Course Characteristics

Wireless communication is a professional course of communication. With the development of information science, the application range of wireless communication is getting wider and wider, and it is necessary for every network worker to learn and master the communication technology skillfully. Therefore, this course has gradually become an important basic course for communication students in colleges and universities and general colleges and universities, which takes machine language as a platform to introduce the ideas and methods of communication system design. Through the study of this course, students should not only master the advanced communication knowledge, but more importantly, they should gradually master the ideas and methods of communication systems in practice, and develop the problem solving and language application ability, which is a distinctive course focusing on cultivating students' exploration and innovation spirit and practical ability.

The teaching goal of the course is to let students master the basic concepts, basic syntax and communication system development methods of wireless communication, master the operation methods of wireless communication through the laboratory practice of on-line communication system development, and improve the communication system development skills through practical problem solving.

3.2. Course Implementation

Course implementation is based on the nature, objectives, content framework and the guiding teaching principles and evaluation recommendations of the course as stipulated in the curriculum standards, with reference to the structure, content materials and presentation of the selected textbooks, combined with the teachers' own teaching quality, experience and style, and from the students' learning level, interests and habits as well as the teaching equipment, resources and environment, etc., in a purposeful, planned and organized manner The process of practicing the essence of the manifest curriculum, reflecting the value of the curriculum, and achieving the goals of the curriculum is comprehensive. There are many factors that affect the implementation of the curriculum, both within and outside the education system. Each factor affecting the implementation of the curriculum does not work alone, but also interacts with each other in a complex way. Among these many factors, the most critical elements are: teachers, teaching materials and training bases. The most important factor in the implementation of the curriculum is the teacher. The teacher's attitude toward the course program and the teacher's ability directly determine the effectiveness of the implementation of the course program. In fact, teachers are active decision makers in the course implementation process, they have to make appropriate judgments and make corresponding adjustments to the curriculum-related issues at any time. Teaching materials are the carrier of certain educational theoretical ideas, the important basis of the curriculum implementation activities, and the key factor to achieve the goal of talent training. Internship base is a necessary condition for the implementation of the curriculum in colleges and universities, and is an essential part of the practical teaching process. Internship bases can be divided into two categories: on-campus internship bases and off-campus internship bases. On-campus internship bases play an important role in students' initial understanding and mastery of relevant literacy and competence requirements.

In October 1999, the Department of Higher Education of the Ministry of Education hosted a national conference on high school teaching materials for colleges and universities. The conference called for the preparation of a series of high-quality teaching materials for communication majors with real characteristics of colleges and universities and a complete system as soon as possible, which can meet the requirements of cultivating technical

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application talents in higher education. As a basic course for communication majors in colleges and universities, this course on wireless communication meets the requirements of college students, is easy to understand, describes complex concepts in simple language that readers can easily understand, starts from simple concepts, allows readers to gradually master the complete system of wireless communication, focuses on training their ability to analyze problems and solve them, and strives for students to be able to use wireless communication after learning this course The course is designed to enable students to write practical applications using wireless communication. But learning computer language is mainly in the application, just by listening to the lecture and reading the textbook is not possible to master.

Therefore, in the implementation of the course, teachers should combine lecture and laboratory classes according to the content of the textbook and the teaching resources of the school, and focus on the hands-on practice sessions for students. Hands-on practice is an indispensable part of learning wireless communication, and many unclear or vague problems can be confirmed through hands-on practice. The debugging of the written program often reveals problems, and the debugging program can solve the errors that occur and improve the students' ability to analyze and solve problems.

4. Embedded Wireless Communication Experimental System Development Platform Establishment

4.1. The Choice of Experimental Development Board

The choice of development board is actually the choice of what kind of embedded microprocessor to use, because the performance of the microprocessor directly affects the function and stability of the entire development board. Although there is a wide range of popular microprocessors on the market, with different functions. ARM can be thought of as a company name, a generic term for a class of microprocessors, and a name for a technology. The traditional CISC (Complex Instruction Set Computer) architecture has the inherent disadvantage that as computer technology evolves and new complex instruction sets are introduced, the computer architecture becomes increasingly complex to support these additional instructions, however, the use of the various instructions in the CISC instruction set However, the frequency of use of the various instructions in the CISC instruction set varies widely, with about 20% of the instructions being used repeatedly, accounting for 80% of the overall program code. The remaining 80% of the instructions are used infrequently, accounting for only 20% of the communication system, which is obviously an unreasonable structure. Based on the above unreasonableness, the concept of RISC (Reduced Instruction Set Computer) was proposed at the University of California, Berkeley in 1979, which did not simply reduce instructions, but focused on how to make the computer structure more simple and reasonable to increase the computing speed. The RISC architecture gives priority to the most frequently used simple instructions and avoids complex instructions; the instruction length is fixed, the instruction format and addressing method are reduced; the control logic is the main focus, and no or less microcode control is used to achieve the above purpose.

At present, RISC architecture is not strictly defined, but it is generally believed that RISC architecture should have the following characteristics.

(1) using a fixed-length instruction format, with 2-3 types of instruction normalization, simplicity, and basic addressing methods.

(2) the use of a single instruction cycle, to facilitate the execution of pipeline operations.

(3) Extensive use of registers, data processing instructions only operate on registers, and only load/store instructions can access memory to improve the efficiency of instruction execution;

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in addition to this, the ARM architecture also uses some special techniques to minimize the area of the chip and reduce power consumption while ensuring high performance.

(4) All instructions can decide whether to be executed based on the previous execution results, thus improving the execution efficiency of instructions.

(5) Data can be transferred in bulk with load/store instructions to improve the efficiency of data transfer.

(6) Logic processing and shift processing can be done simultaneously in the middle of a data processing instruction.

(7) Use of automatic address increment/decrement in loop processing to improve the efficiency of operation.

Of course, compared with the CISC architecture, although RISC architecture has the above advantages, but must not think that RISC architecture can replace the CISC architecture, in fact, RISC and CISC have their own advantages, and the boundary is not so obvious. Modern CPUs often adopt the periphery of CISC and add the characteristics of RISC internally, such as the ultra-long instruction set CPU is a fusion of the advantages of RISC and CISC, which becomes one of the future CPU development directions.

4.2. Advantages of the Embedded Wireless Communication Experimental System

In summary, the experimental system has several advantages as follows.

(1) support such as USB, LCD, SM and other interfaces, to facilitate future expansion of experimental projects, and system upgrades.

(2) the use of the popular uClinux operating system, closely following the pulse of the development of embedded systems. With the continuous enhancement of uClinux functions, in the subsequent experimental program design can get more design space, can complete more experimental design functions.

(3) cost, low maintenance costs. With the development of embedded systems. The price of the main chip used in the development board will continue to fall, so both its manufacturing costs and maintenance costs will be very low

(4) the use of high-quality GPRS module, not only to develop wireless communications and voice services experiments, but also wireless access to the internet, to complete experiments in wireless network applications.

(5) a wide range of experimental projects. So that the set of experimental system configuration can not only fully adapt to the current stage of experimental requirements also has a strong scalability for the future design of more experimental projects to create the conditions, and economic and practical. Experimental design purpose and requirements BootLoader is a very important part of learning embedded system.

It is closely integrated with the hardware, through the study of its structure, principles and practical hands-on writing simple BootLoader program will help to understand the embedded system more deeply. Therefore, it is a very important experimental project as well as the establishment of the root file system of uClinux, and these two experiments can lay a good foundation of hardware and software knowledge for future experiments of application communication system. These two experimental projects will allow students to familiarize themselves with the experimental platform, master the ARM architecture and its boot initialization process, and be able to skillfully apply Thumb instructions and C to write initialization programs.

At the same time, they can also understand the file system of uClinux, master the compilation method of kernel and the creation method of root file system. It can be said that these two experiments are the preparation tests for all embedded experimental projects. The whole

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experiment involves more contents, and the experiment participants introduce the project management contents, divide the project work to propose the schedule, and establish the responsibility matrix and evaluate it by the date.

5. Solution Design of the BootLoader Experimental Project

5.1. The Concept of Bootloader and the Theoretical Basis for Its Design

We have introduced the four levels of the uClinux operating system, starting with the BootLoader, an applet that runs before the operating system kernel runs. It initializes the hardware devices and creates a memory map to bring the system hardware and software environment to a suitable state in order to prepare the correct environment for the final call to the OS kernel. This is what we call the bootloader. In embedded systems, there is usually no firmware program like PC BIOS, so the whole system loading and booting task is done entirely by BootLoader. For our experimental development board, as the flash is connected to the microprocessor Bank0 chip select signal. The mapped address is 0x00000000, and the experimental system is executed from address 0x00000000 at power-on or reset, so the BootLoader program of the system is arranged at this address.

Since the BootLoader is very closely integrated with the hardware, its BootLoader program is different for CPUs of different architectures. Because of this, it is important to have an overall understanding of the register structure of the S3C44B0X. The ARM processor has 37 registers, divided into several groups (banks), which include

(1) 31 general-purpose registers, including the program counter (PC pointer), all of which are 32-bit registers.

(2) 6 status registers to identify the operating status of the CPU and the running status of the program, all 32 bits, only some of which are currently used. Specific implementation of the system establishment experiment

5.2. Setting up the Arm-Linux Cross-development Environment

To develop and debug applications under uClinux, we must first establish a cross-development environment on the host computer, so that the host computer can compile and generate code that the experimental development board can run. Our host development environment is RedHatLinux 9.0 (kernel 2.4.18, gcc3.2, glibc2.2.93). The next step is to prepare a copy of the uClinux source code. The good thing is that uClinux is an open source operating system and can be easily downloaded on the Internet. Here we are using.

(1) pure Linux-2.4.x kernel (already well ported to S3C44B0X).

(2) uClinux-dist-20030522.tar.gz In addition there is the ARM cross-compiler that allows us to compile on a PC to get the OS kernel running on an ARM7 microprocessor. We download the ARM cross-compiler from the Internet: arm-elf-tools-20030314.sh. Execute the following command on the host computer: sharm-elf-tools-20030314.sh This command will automatically create a uClinux-ARM cross-compilation environment on the development host computer after execution. Once the cross-compilation environment is established, we will proceed to recompile the uClinux kernel to generate the OS kernel and ROMFS root file system.

6. Letter and Voice Communication Application Communication System Experiment Example

6.1. The Purpose and Requirements of the Experiment

The soul of embedded system is the design of embedded software. Through the experiment, you can deeply understand the working process of GPRS terminal and the related AT control instructions. Familiar with Linux operating system and related system functions, skillfully

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develop with wireless communication communication system under Linux environment, compile the connection program using cross-compilation tool and debug the program using GDB. Master the method of filling uClinux application. The whole experiment involves a lot of content. The experiment participants introduce project management content, divide the project into tasks, propose a schedule, and establish a responsibility matrix to evaluate it on schedule. The experiment concluded that the SMS sending and receiving, reading, deleting and voice communication functions were completed on the host terminal by entering command lines, and data exchange and processing between the host and the experimental development board, and between the experimental development board and the GPRS terminal were realized. We have used AT commands to control the GPRS terminal, and we have learned and mastered a whole set of application development methods from program writing, cross-compiling and connecting to debugging under Linux environment.

6.2. Extended Experimental Project

The development board is equipped with an LCD interface. By porting the miniGUI and filling in the LCD driver under uClinux, you can develop internet-related experimental projects with the network port and the TCP/IP protocol stack built into uClinux. If you use GPRS module, you can write the ppp link script file under uClinux to make the experimental system automatically access the internet through GPRS network and realize the experimental projects related to wireless access. In addition, experiments such as USB driver development and storage expansion of embedded systems can be conducted.

7. Conclusion

At present, the research and application of embedded system and wireless communication are in full swing at home and abroad, but there are few experimental projects combining the two in university campus. In order to change this situation and adapt to the trend of electronic technology development, this paper proposes a set of ARM-based embedded wireless communication experimental program. The program includes a complete set of contents from hardware selection, embedded experimental platform construction to application writing under embedded operating system. In the design of specific experimental program, the openness and innovation are highlighted, and three experimental contents are designed for students with strong business ability and hands-on ability: the design of BootLoader, the creation of uClinux kernel and ROMFS root file system image file, and the writing of short message and voice communication applications. In addition, each experiment provides sufficient theoretical basis or preparatory knowledge, but does not give specific implementation methods, in other words, it gives the experiment participants more room to play, so that the cultivation of ability is not limited to the technical level but extends to the cultivation of project management and organizational ability, which is a great improvement over the previous verification experiments.

The hardware makes full use of the ARM7TDMI microprocessor, which is economical and practical, supports a variety of interfaces, supports a variety of operating systems, and is highly scalable. A hardware platform that can carry out various embedded experiments is built, not only limited to network-related application experiments. In terms of wireless network access devices, we choose GPRS terminal to access GPRS wireless network belonging to 2.5G. The hardware platform with GPRS terminal can adapt to the development of wireless technology and related services in a relatively long period of time in the future, to complete more and more complex embedded wireless communication experimental tasks. Thus, this set of experimental system really reflects the advantages of high cost performance, adaptability and scalability.

The program coherent three experimental examples: BootLoader design, uClinux kernel and ROMFS root file system image file production, short message and voice communication

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application design, the first two experimental examples, especially the BootLoader design can be said to be all embedded experiments in preparation for the experiment. The design of BootLoader has strong hardware relevance, and the creation of uClinux kernel and ROMFS root file system image file involves part of the knowledge of embedded operating system. With the completion of these two experimental projects, students will have a deep understanding of the ARM7TDMI architecture, the boot process, the Linux operating system, and a good grasp of the Thumb instructions, wireless communication system development and file compilation methods in the Linux environment, laying a solid foundation for the subsequent use of modular ideas to write applications. In the design of the experimental project throughout the layers of approaching the idea, and completed by hand the entire experimental specific content design, as a reference.

I believe that with the continuous development of embedded systems, more experimental projects will be developed. So that students in the experimental process to appreciate the beauty of science and technology to improve the practical hands-on ability at the same time also walk in the wave of technological development. And the set of experimental system will also play an increasingly large role.

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