Web based C-language E-Learning System with Controllable Four-axis Robot Arm

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Abstract. The evolution of technology makes human knowledge gradually digitized, and many traditional teaching or learning methods in a class are also evolving towards the Web via courseware sharing on the Internet. Different from the traditional teaching and learning way, e-learning can provide a variety of courseware and a more flexible learning environment. Researches find that the students are more interested in diversified e-learning environments and the feedbacks are positive.

Because open source software possesses the advantages of freedom, safety and low cost, our research establishes the e-learning system with a robot arm and integrates many open source software such as Moodle, DDD and MSPGCC. By merely using Web browsers, students can make a remote connection to the devised e-learning system, proceed to the process of learning, practicing and manipulating of the robot arm, and monitor the interactive results including real-time images returned by an IP-Cam all on Web pages.

The contribution of this paper is that we devised an e-learning system and utilized it as a remote learning platform for C programming language allowing students not only to exercise C programs, but also to control the robot arm and see how it works. Meanwhile the system provides many robot control examples of C language learning/laboratory units such as for-loop and if-else structures. With the system, learners can practice C programming without time and place limitations and very likely, they can achieve better learning performance due to the motivation of the remotely controllable robot arm.

Keywords: C programming language, E-learning, E-laboratory, Moodle, MSP430, Robot arm.

1. Introduction

The traditional embedded system curriculum is often subject to the place and equipment such that theory reasoning and explanation take the most of class time. This type of curriculum usually needs to practice more laboratories to obtain a better understanding, while over-cumbersome theory explanation makes the time for the students to operate and exercise drastically compressed [1]. In addition, C programming language learning is a basic requirement for this kind of curriculum, but the learning status and progress of all students might not be totally known by a teacher and therefore learning effectiveness is relatively decreased. Although some teachers will set up a teaching website or message board for the students to ask questions, the students who do not understand the curriculum very well cannot describe many issues in detail and finally cannot obtain the right solutions to their issues [2].

The e-laboratory system which currently has developed mainly combines many kinds of software, such as Moodle, MSPGCC, and DDD etc. It was devised to make the students practice laboratory units learning, acquire the sample program, and compile and flash the executable program simply by a WWW connection [3]. Therefore, through a browser, students can monitor and understand the laboratory units immediately by the execution results of their codes via real-time images streamed by IP-Cams.
Based on the aforementioned system, the study further develops a comprehensive C programming language e-learning platform with more flexible usability comparing to other platforms, as shown in Tab.1. The main purpose for this study is pertaining to C programming language teaching for establishing a better basis for more advanced courses such as embedded systems. The proposed system provides syntax examples of C language learning units, together with the robot arm to exhibit the living result after execution. The system can be applied to embedded system related C programming language courses making C programming language more easier to learn and more interesting. In this way, we can employ the system as a platform for students to inspire their creativity and to enhance their interest of C language learning.

Tab.1 Comparison of general distance learning and this system.

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2. System Design

2.1. System Architecture

The devised system is mainly established in Ubuntu operating system [7], as shown in Fig.1. Users can proceed to the process of learning, practicing and manipulating the embedded system equipped with a robot arm using C programming language. About course contents, we refer to the web sites “CodingUnit Programming Tutorials” to use text description as the main teaching methods [8]. Connecting to this system via a browser, the user will see the curriculum and sample programs established on the Moodle platform. Real-time images returned from the IP-Cam can make students understand and realize the actual operating situation after the program being executed [9]. This kind of curriculum can make students learn more conveniently and drastically enhance flexibility of possible learning time and meanwhile increase the learning interest for the students as well.

Fig.1 System architecture diagram.

2.2. Software Integration

Most of software introduced in the following belongs to open source projects, not only having the advantages of low cost benefit and convenient for use but having higher flexibility for software integration as well and is broadly used in many technical/vocational colleges/universities or private institutes.

2.2.1 Ubuntu 8.04 LTS
Ubuntu 8.04 LTS is a graphical interface Linux operating system; it emphasizes user-friendly interfaces and is based on Debian and GNOME desktop environment. Because Ubuntu operating system has proper hardware support and good system safety, it is selected to build our server.

2.2.2 Moodle

Moodle is an online teaching platform. On account of open source, there are many relevant kits and modules which can be downloaded and acquired from the official Moodle website, and it can be installed easily. Because protected by GNU GPL, any distribution of modified Moodle needs to release source code publicly.

2.2.3 DDD

DDD is the abbreviation of data display debug. It is a graphic debugging interface and can cooperate with debuggers, such as GDB, DBX, WDB, etc. In the proposed system, DDD is used to debug C programming language on an MSP430 microcontroller.

2.2.4 MSPGCC

GCC (GNU C Compiler) is a powerful compiler. In the system, it is mainly used to compile C programs into an executable code which can be executed by MSP430 so that the student can develop, practice and apply the MSP430 module.

2.3. Hardware Integration

2.3.1 4-Axis Robot Arm

This 4-axis robot arm is produced by Catcan Creative company with MSP430F449 in replacement of original core used in the system. The robot arm needs a working voltage of DC 6V and a working current of 0.6A-2A. The extension distance can achieve 230mm vertically and the horizontal rotation angle can achieve 180°. It can squeeze an object of 60g with width of 35 mm at most and control a motion using PWM analogous pulse signal from 500µs-2500µs. It is a fundamental robot arm and can be used to represent the motion after the user executes the program.

2.3.2 MSP430F449

The development board adopted by this system is a low power electricity saving microcontroller -- MSP430F449 developed by TI (Texas Instruments). It is a CPU of a 16-bit reduced instruction set (RISC). It adopts von Neumann architecture, provides many kinds of work model which can be switched via a configuration register. This microcontroller possesses many peripheral pins for other devices. In addition to a basic input and output port, it also includes a 12-bit analog to digital converter (ADC), time processing unit, synchronous and asynchronous transmission interface (USART), and a LCD driving circuit of a 160-word paragraph. It is a quite complete development environment for teaching.

2.3.3 IC-200 Dual IP-Cam

This system adopts the product of WEICHU company. IP-Cam has a built-in web server, so as long as connected to the network port and power line, connection and control can be carried on. The IP-Cam is convenient to transmit real-time images for e-learning platforms and can be easily installed.

3. System presents

Implementation of this system is to achieve the purpose that users can learn easily. Making use of merely Internet and a browser, users can create a remote connection to the system to carry on learning, exercise, implementation and research of the basic embedded system C programming language and represent the experiment result by 4-axis robot arm via IP-Cam in a webpage to enhance learning interest. The operational procedure and process are quite simple, as shown in Fig.2.

The operational screen is as follows:

3.1 After the students input account number and password, they can enter the e-learning platform of this system and select the curriculum unit in the curriculum catalogue which they want to learn, as show in Fig.3.

3.2 After the students browse the curriculum content, they can write a program and do exercises and finish program compilation and burning by clicking a button, as shown in Fig.4.
3.3 After program burning, the students can know the experiment result via a returned screen from the IP-Cam, as shown in Fig.5.

Fig.2 Students process flow diagram.

![Fig.2 Students process flow diagram.](image)

**Embedded Systems Programming Language Learning System**

![Embedded Systems Programming Language Learning System](image)

**Process control**

![Process control](image)

**Real Time**

![Real Time](image)

**Enter The Code**

![Enter The Code](image)

Fig.3 The web pages for C programming language learning system.

Fig.4 C programming language “for loop” course pages.

Fig.5 Compile the code and get the real time results.
4. Conclusion

The paper presents a remote interaction e-learning platform to assist in teaching of C programming language for embedded systems. Its purpose is to accommodate the students with a more diversified learning environment and increase their creativity, logic thinking and learning interest of the students. The proposed system integrates many kinds of open source and can effectively reduce the implementation cost of the laboratory units in school.

Users can connect to the system merely using Internet and browsers. At the server side, we establish the system on the Moodle platform. The real compilation and burning instruction are all presented on the web pages. Likewise, the system exhibits resulting laboratory images on the web pages via an IP-Cam. In this way, our system effectively assists the students in laboratories operation and C language learning; meanwhile it can be used to enhance learning effectiveness and provides a new method for remote laboratory of C programming language.

In addition, the platform is still at the research stage of an experimental prototype. Many learning functions are under tests online only between a few laboratory computers. In the future, we will expand the scale of the learning platform, and aim at the research related to network traffic reduction of the whole system.

5. References


