Design and Development of Online Distance Learning System for Electrical Automation Technology Specialty

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Abstract. In order to improve the response speed of distance learning system for electrical automation technology specialty, a new online distance learning system for electrical automation technology specialty is designed. In the hardware part, mainly through the selection of microprocessor, power supply mode and download circuit, built-in memory module, external memory module and communication module design to complete the system hardware design; on this basis, mainly through the login process, system management process and database design to achieve system software design. The experimental results show that the response speed of the online distance learning system of electrical automation technology is fast, and the students' performance has been significantly improved after the application of the system.

Keywords: Electrical automation technology · Online distance learning · Microprocessor

1 Introduction

Electrical engineering and automation is an emerging discipline in the field of electrical information. It is closely related to people's daily life and industrial production. It has developed very rapidly, and it is relatively mature. It has become an important part of the high-tech industry, widely used in industry, agriculture, national defense and other fields, and is playing an increasingly important role in the national economy. Its tentacles extend to all walks of life, ranging from the design of a switch to the research of aerospace aircraft. Students of this major are able to work in the fields of system operation, automatic control, power electronic technology, information processing, experimental technology, research and development, economic management, and electronic and computer technology applications related to electrical engineering. They are a wide-caliber "composite" advanced engineering and technical personnel. There is a great demand for high-level talents in this field. It is estimated that with the entry of large foreign companies, there will be a large gap in this professional field, and there is likely to be a shortage of talents at that time.

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At present, the construction of teaching network for electrical automation technology has been gradually improved, and the process of teaching informatization is also gradually promoted. Computer technology and network technology have been applied to the process of online education. With the rapid expansion of contemporary information technology in vocational education, with the application of multimedia computer in education and teaching becoming more and more common, the online distance learning system of electrical automation technology specialty has achieved further development, Therefore, it is of great significance to design an online distance learning system for electrical automation technology specialty.

2 Hardware Design of Online Distance Learning System

The hardware framework of the online distance learning system for electrical automation technology in this research is as follows (Fig. 1):

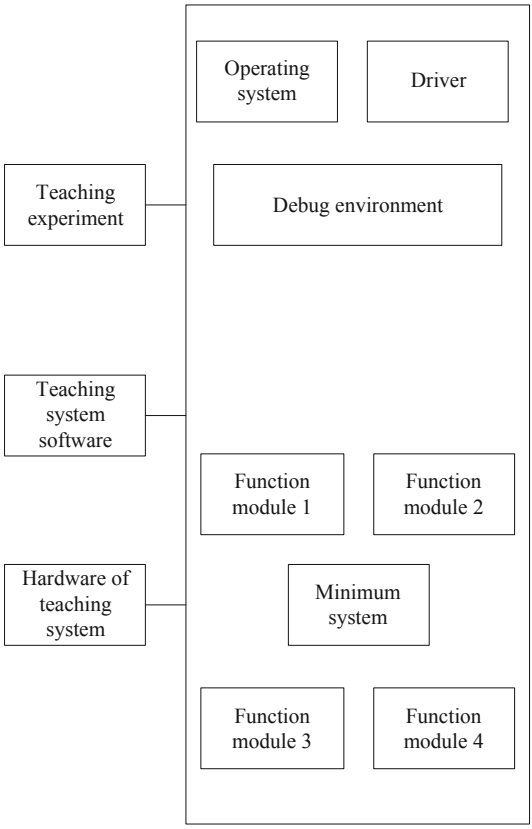

Fig. 1. Hardware framework of online distance learning system for electrical automation technology major

2.1 Microprocessor Selection

Cortex-M3 adopts ARMV7 architecture, which not only supports Thumb-2 instruction set, but also has many new features [1]. Compared with ARM7TDMI, Cortex-M3 has many advantages, such as stronger performance, higher code density, bit band operation, nested interrupt, low cost and low power consumption.

This paper chooses STM32F103ZET6 as MCU. There are many models of STM32F103. The reason why we choose this one is that we value its cost performance. As a low-end development board, choosing STM32F103ZET6 is the best choice. 128KFLASH, 20KSRAM, 2 SPI, 3 serial ports, 1 USB, 1 CAN, 2 12 bit ADC, RTC, 51 available IO pins [2], such a configuration is very good no matter where it is put. What's more important is its price. The batch price of less than 13 yuan is enough to kill many other chips, so it is chosen as the main chip.

2.2 Power Supply Mode and Download Circuit

Circuit Design of Power Supply Part

The teaching system of this study is equipped with a USB serial port [3] and is powered by USB, so that only one USB cable is required to use the ALIENTEKMiniSTM32 development board, including downloading, power supply, and debugging. The power supply part of the experiment board also leads to 5 V and 3.3 V pin headers, which can provide power for external devices or introduce power from outside [4], which is very useful in many cases, sometimes you suddenly need a 3.3 V power supply, But there is no such power supply for a long time, and the device provides 3.3 V, 5 V power to external devices. The USB interface is led out through an independent MiniUSB header, not shared with USB_232, so that it can not only be used at the same time, but also can provide greater current to the system.

One Click Download Circuit

The specific implementation process of one click download circuit [5]: first, mcuisp controls DTR output low level, then DTR_N output high, then RTS set high, RTS_N output is low, so Q2 is turned on, boot0 is pulled high, that is, BOOT0 is set to 1, Q1 is also turned on, and the reset pin of STM32 is pulled low to realize reset. Then, after a delay of 100ms, mcuisp controls the DTR to a high level, and the DTR_N output low level, RTS maintain high level, RTS_N continues to be at low level. At this time, the reset pin of STM32 becomes high level because Q1 is no longer on. STM32 ends to reset, but boot remains at 1, thus entering ISP mode. Then mcuisp can start to connect STM32 and download the code, so as to realize one click download [6].

In addition, there is a switch K1 in this part to control the power supply of the entire system. If it is disconnected, the 3.3 V part of the entire system will be powered off. The power of the 5 V part is still on. F1 in the picture is a recoverable fuse, used to protect the USB. In addition, this experiment board also adds two TVS tubes, D4 and D5, to

protect the development board and prevent external high-voltage pulses/static electricity from damaging the components on the development board [7].

Button and LED Display Circuit

There are three buttons and three LED in the development board, and the schematic diagram is as follows (Fig. 2):

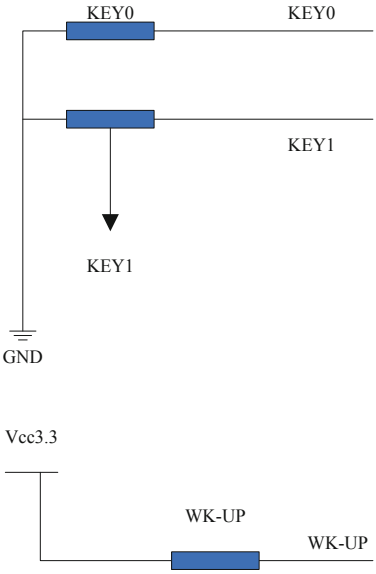

Fig. 2. Button circuit

KEY0 and KEY1 are used as common key inputs, which are connected to PA13 and PA15 respectively. They are all connected to JTAG related pins (KEY0 is also connected to SWDIO). In this way, when using KEY0 and KEY1, JTAG can not be used for debugging, which should be noted when using. KEY0 and KEY1 are also shared with DAT and CLK lines of PS/2. They both provide pull-up through pull-up resistor of JTAG. WK_The up key is connected to PA0 (WKUP pin of STM32), which can be used as a wake-up input of STM32 in addition to ordinary input key [8]. This button is triggered by high level. PA0 is also the input pin of DS18B20, so pay attention when using it.

2.3 Built-in Storage Module Design

EEPROM

In EEPROM, A0–A2 are all grounded. For 24C02, the address bit is set to 0. Pay attention to this when writing programs. IIC_SCL connected to PC12 of MCU, IIC_SDA is connected to PC11 of MCU, but it is not connected to IIC of STM32, because IIC of STM32 is chicken ribs! If you want to use the hardware IIC on the ALIENTEKMiniSTM32 development board, you can also use the hardware IIC by setting pc11 and

PC12 as floating inputs, and then connecting PB10 and PB11 (IIC2) or PB6 and PB7 (IIC1) to PC11 and PC12 through flying wires.

SPIFLASH

This development board is equipped with SPIFLASH chip W25X16. The chip has a capacity of 2M bytes, which is at the same level as AT45DB161. The price of ATMEL products has been very unstable recently. Therefore, we have chosen a stable price, good supply, and strong versatility. W25X16. W25X16 also shares SPI1, and F_CS is connected to PA2. So far, a total of the four devices of SPI1 have been introduced, and their CS are all connected to different IO ports (except for the two wireless modules), so when using one of the devices, remember to disable the CS pin of other devices, otherwise there will be interference.

W25Q64 is a high-capacity SPIFLASH product launched by Huabang company. The capacity of W25Q64 is 64MB. This series also has W25Q80/16/32 and so on. The W25Q64 selected by ALIENTEK has a capacity of 64MB, that is, 8M bytes. W25Q64 divides the capacity of 8M into 128 Blocks, each block size is 64K bytes, and each block is further divided into 16 Sectors, each sector is 4K bytes. The minimum erasing unit of W25Q64 is one sector, that is, 4K bytes must be erased each time. In this way, we need to open up a buffer area of at least 4K for W25Q64, so the SRAM requirement is relatively high, and the chip must have more than 4K SRAM to operate well.

W25Q64 has up to 10W erase and write cycles, has a data retention period of 20 years, and supports a voltage of 2.7–3.6 V. W25Q64 supports standard SPI, and also supports dual-output/quad-output SPI. The maximum SPI clock can reach 80 MHz (double the output is equivalent to 160 MHz, and the four-output is equivalent to 320M). For more information about W25Q64, please refer to the DATASHEET of W25Q64.

2.4 External Memory Module

This development board contains a standard SD card interface, with this interface, you can expand the capacity of storage devices, can be used to record data. The schematic diagram is as follows:

SD card we use SPI mode communication, the SPI interface of SD card is connected to SPI1 of STM32, SD_CS is connected to PA3, and SPI1 on ALIENTEKMiniSTM32 development board is shared by four peripherals: SD card, NRF24L01 wireless module, JF24C wireless module and W25X16. They can be time-sharing multiplexed by different chip selection signals.

2.5 Communication Module

The embedded teaching experiment development board contains two wireless module interfaces, NRF24L01 module and JF24C/D module. They are all wireless modules of 2.4G communication, and have the characteristics of high cost performance. The maximum communication rate of NRF24L01 is 2 Mbps, and that of JF24C/D is 1Mbps. With these two interfaces, wireless communication can be realized.

NRF24L01 wireless module adopts NRF24L01 chip [9]. The main features of the chip are as follows:

1) 2.4G global open ISM frequency band, license-free use.
2) The highest operating rate is 2Mbps, efficient GFSK modulation, and strong anti-interference ability.
3) 125 optional channels to meet the needs of multipoint communication and FM communication.
4) Built-in CRC error detection and point-to-multipoint communication address control.
5) Low working voltage (1.9–3.6 V).
6) Automatic response can be set to ensure reliable data transmission.

The chip communicates with external MCU through SPI, and the maximum SPI speed can reach 10 MHz. The module we use in this chapter is NRF24L01 produced by Shenzhen Yunjia technology, which has been widely used by many companies, and its maturity and stability are quite good.

The voltage range of VCC pin of the module is 1.9–3.6 V. It is recommended not to exceed 3.6 V, otherwise the module may be burnt out. Generally, 3.3 V is suitable. In addition to VCC and GND pins, other pins can be directly connected with the IO port of 5 V MCU. It is precisely because it is compatible with the IO port of 5 V MCU that it has great advantages in use.

3 Software Design of Online Distance Learning System for Electrical Automation Technology Major

3.1 Login Process Design

Login system gives students and teachers the management authority to use the system, and provides different services for different objects to achieve detailed user authority management. The main functions are as follows:

(1) It provides an interface for teachers and students to log in to the education system, which is convenient for teachers and students to input their account numbers and passwords;
(2) Teachers and students can register their account and password through the registration page, and the system will automatically obtain the MAC of the login device of teachers or students record the address and check whether the account and password have been registered. If the account and password have been registered, you will be prompted to return to login without registering again. If you forget the password, you need to check with the administrator and retrieve the account and password. If the registration is successful, you will be prompted to register successfully and return to the login page. You can log in to the system on the login page.
(3) Verify according to the input of teachers and students. If teachers and students log in to the system and input the account and password at the time of registration, the verification will pass and enter the corresponding system page. If it is not correct, they will not be able to get permission through verification to enter the system, and they will return to the login page and prompt to re-enter [10]. The specific function flow chart is as follows (Fig. 3):

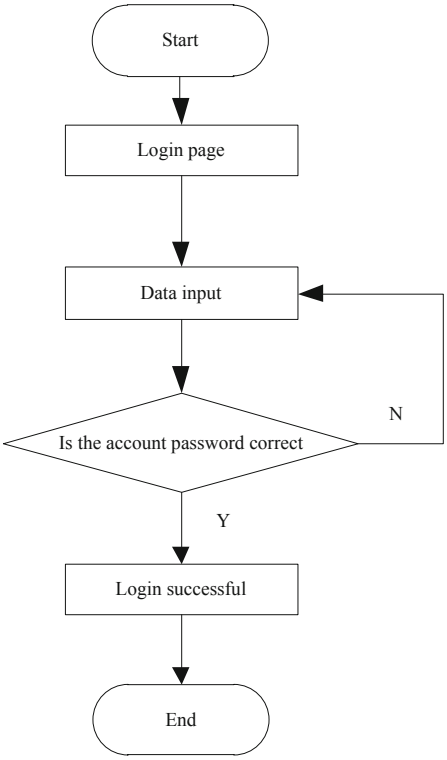

Fig. 3. Flow chart of login system function design

3.2 System Management Process Design

Teacher management system is one of the most important parts of the whole online education system. It is mainly composed of five modules: information management, class process, online video, submission of materials and message reply. Teachers can realize the basic functions of online teaching through these five modules [11, 12].

Information management module: the information management module mainly refers to the students connected to the teacher's classroom, understanding the basic information of students and managing the information of students, including deletion and modification.

Class process module: the class process module is mainly for teachers to chat and guide the students who have entered their own classroom in real time, and to answer the students' problems in time, which is interactive and timely, and can improve the students' learning enthusiasm [13]. The flow chart of function design is as follows (Fig. 4):

Video management module: video management module is mainly to achieve online video playback, teachers can upload teaching video materials through the module, and manage, classify and delete the uploaded video materials, while students can only watch online video through the online video module of student management system [14].

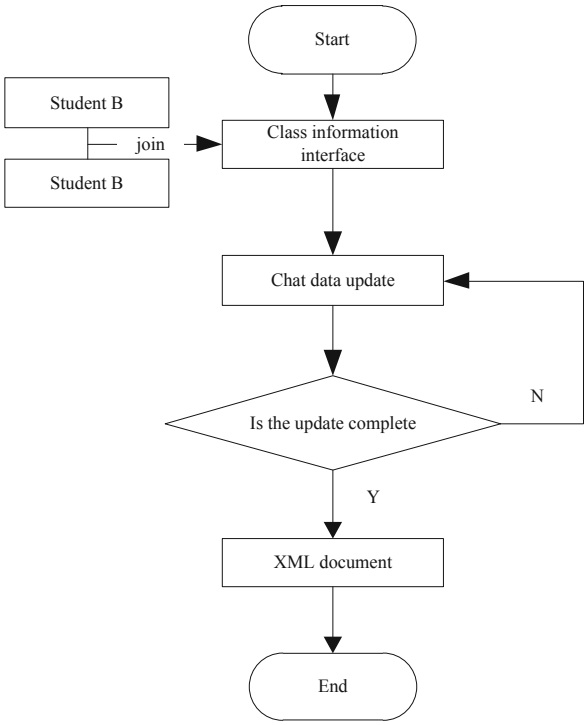

Fig. 4. Function design flow chart of class process

Message reply function module: the message reply function is mainly for teachers to display and reply to their own classroom students' after class messages, so that students can provide a questioning module for the questions that they did not think of in time in the process of class, and teachers can reply to the messages after seeing them.

Upload data module: upload data module is mainly for teachers to upload some teaching materials for students to download and learn. Teachers can upload less than 100MB of materials through this module, including review materials such as exercises after class. You can delete the uploaded data.

3.3 Database Design

According to the setting of the data storage structure, the data of the technical school online education system can be divided into three tables to store, but the teacher-based information is relatively small, and the student data can be stored together in an xml document, so they are designed separately the two data tables of teacher and student information data table and chat record table are as follows.

(1) Teacher-student information data sheet. The teacher-student information data sheet is mainly used to record the teacher's account, password, name, class ID and the student's name, identity, account number, password, class ID, registration time

and other information [15]. The specific table the structure design is shown in the following table (Table 1):

Table 1. Structure data of teachers and students

Serial number	Element description	Data type	Remarks
1	Number	Character	Primary key
2	Full name	Character	
3	Registration time	Date time	
4	Account number	Character	
5	Password	Character	
6	Identity type	Character	Teacher/student
7	Class ID	Character	

Chat record table and chat record information table are mainly used to record the chat record during class and the message record after class. The following tag elements are applied, and the specific table structure is designed as follows: (Table 2)

Table 2. Chat record data table

Serial number	Element description	Data type	Element length
1	Message main element		
2	Full name	Character	10
3	Message text	Character	300
4	Message reply	Character	300
5	Main elements of online chat		
6	IP address and port	Character	20
7	Text message of online chat	Character	300

At the same time, when storing system data, it was decided to use XML technology, combined with the call of the PHP programming language, to realize data storage and reading, and to abandon large databases such as SQL to increase the speed of data reading.

Mainly use the SIMPLEXML function in PHP. SIMPLEXML is a new feature extension in PHP. The SIMPLEXML extension provides a simple way to get the names, tags and text of XML elements. Compared with other parsers such as DOM, SIMPLEXML

can read and write text data from XML elements with just a few lines of code, which is easy to recognize and remember. SIMPLEXML can convert XML documents or XML strings into objects. For example, elements are converted into single attributes of SIMPLEXMLELEMENT objects. When there are multiple elements on the same level, they will be placed in the array. Properties are accessed by using associative arrays, where the index corresponds to the property name. The text inside the element is converted to a string. If an element has multiple text nodes, they are arranged in the order in which they are found. SIMPLEXML is very fast to use when performing basic tasks such as reading/extracting data from XML files/strings, editing text nodes or attributes.

SIMPLEXML extension is a tree based parser, which stores the whole document as a tree data structure. It needs to load the whole document into memory to work. Its structure is shown in the following figure (Fig. 5):

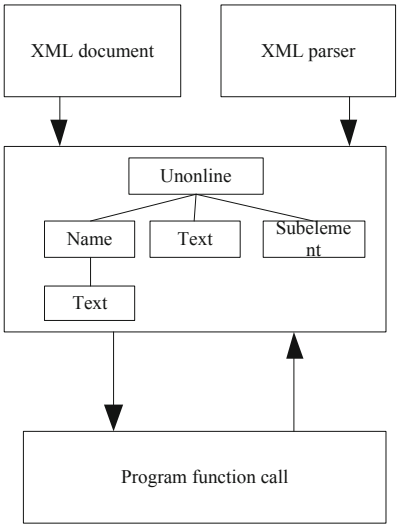

Fig. 5. XML reading and writing process

In this way, the design of the system software is completed through the above process.

4 Experiment

In order to verify the effectiveness of the designed online distance learning system for electrical automation technology specialty, the experimental analysis is carried out, and the traditional online distance learning system based on information technology is compared with the research system, and the effectiveness of the two systems is compared.

In this paper, the experimental test is carried out under the environment of Intel Xeon Gold6254@3.10 GHz(X2)CPU, 768Gbram, 2× Teslav100GPU, WindowsServer2019 and Matlab. The experimental objects of this paper are the system designed in this paper and the traditional system. By setting the experimental environment and objects, the scientific nature and reliability of the experimental results can be improved.

4.1 System Response Speed Comparison

The results of response speed comparison between the research system and the traditional system are shown in the figure below (Fig. 6).

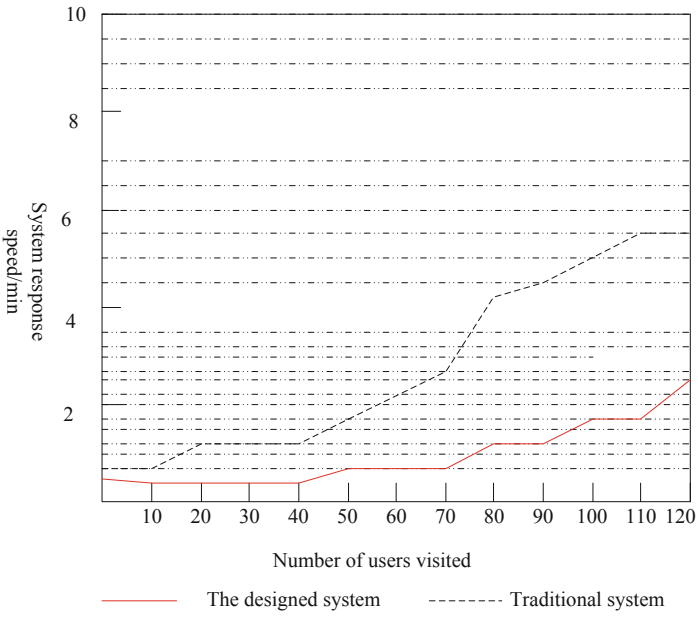

Fig. 6. Comparison of system response speed

Through the analysis of the figure above, it can be found that the response speed of the system in this study is faster than that of the traditional system. Although the response speed of the two systems is reduced due to the increase of concurrent users, the system in this study is less affected and has better application effect and faster response speed than the traditional system.

4.2 Student Achievement Comparison

Comparing the students' academic performance after applying this system and the traditional system, the comparison results are as follows (Table 3):

Through the above table, we can find that the students' academic performance is significantly higher than that of the traditional system, which proves the effectiveness of the research system.

Table 3. Comparison of student performance

Student	Student scores/points after applying this system	Student	Student grades/points after applying the traditional system
1	98	1	85
2	95	2	86
3	98	3	84
4	97	4	81
5	98	5	80
6	95	6	78
7	98	7	75
8	96	8	70
9	95	9	72
10	98	10	70

5 Concluding Remarks

According to the educational needs of an institution, based on the realization of the basic teaching functions of the system, with the main goal of improving the response time and speed of the website, the module function design of the system through research and analysis, and the key technologies to realize each module are researched and tested, build an online education system with students and teachers as the main service objects, design a new teaching model for electrical automation technology education, innovate the teaching model of a school, share a large number of teaching resources, and promote teaching in a technical school Education is advancing with the times. The work done mainly includes:

Firstly, combine the educational and teaching needs of the electrical automation technology professional online education system, including the technical school online education login system, teacher management system, and student management system. It is divided into personal information, class process, online video, and posting messages, Submit documents and other related modules for detailed design;

Secondly, use XML technology to replace database technology for data storage to increase data storage speed, reduce system burden, and improve response speed.

Therefore, the system can be applied to the teaching process of electrical automation technology, in order to solve the shortcomings of traditional learning mode, improve the teaching quality of electrical automation technology, and promote the further development of modern education.

Because this paper does not test the other performance of the system in the experimental part, more experiments are needed in the future to further optimize the performance of the online distance learning system for electrical automation technology specialty, so as to improve the applicability of the system.

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