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Design of Image System Based on Embedded ARM Experimental Teaching

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ABSTRACT

With the continuous development of computer and image processing technology, image systems have been widely applied in various fields. To enable students to master embedded systems and image processing technology better, carrying out image system design based on embedded ARM experimental teaching is of great significance. The article first introduces the basic concepts and principles of embedded systems and image processing technology and elaborates on the purpose and significance of image system design based on embedded ARM experimental teaching. Next, the article provides a detailed description of the hardware design and software implementation of the imaging system, including the selection of ARM processors, the selection of image acquisition modules, and the design of image processing algorithms.

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1. Introduction

The computer-embedded system has a high requirement for the function, cost, volume, and energy consumption of the computer, and it is composed of an embedded processor, hardware facilities, embedded system, and application system [1]. It results from the combination of computer technology, microelectronics technology and multimedia technology, and it is designed to meet users' needs. At present, the most important hardware in embedded systems is ARM. Since the development of ARM technology in IP technology, embedded systems based on ARM have become increasingly popular [2-4].

With the development of embedded systems in different industries, China's colleges and universities have begun teaching embedded system-related courses, such as computer engineering, operating systems, circuit systems,

etc. In addition, the embedded system course is the main part of college students' electronic science and technology subjects. However, at present, due to the late start time of embedded systems, a lot of work is still needed to build an embedded system into a complete and mature subject. The problems of embedded subjects are listed, and the corresponding treatment measures are also put forward in this paper.

In the traditional embedded teaching system, there are the following problems: the content of the embedded system experiment is relatively simple. In domestic colleges and universities, the experimental content of the embedded system is simple and less [5-7], which can't be combined with the actual embedded system or can't be based on the needs of students to adjust the difficulty of the experiment and content. This is the most urgent problem to be solved in teaching embedded systems in universities. In our country, traditional teaching has always attached importance to the demonstration and ignored student participation, and so does the education of embedded systems. The content is not closely combined with the actual situation: the embedded system education is mainly based on experiment teaching, which requires students to work in person to verify the experiment's results. At present, most education only pays attention to the results while ignoring the process, which also reflects the actual neglect of students' participation [8]. At present, in the experimental course, the teacher demonstrates the operation of the embedded system. Then, according to the experimental manual, students can gradually complete the observation of the test script that the teacher has already completed in advance. This means that the task of the students is to complete the teacher's assignment, and students are too little to think about the basic principles of embedded systems and the necessary process. This is also one of the main reasons for college students' lack of practical ability [9]. The operating process of the experiment teaching is too complicated: the experiment teaching of embedded operating systems needs to be based on the computer and experiment box to establish a common development environment [10]. Currently, in various operating systems cross-development environments, the preparation of the experiment is too cumbersome, and the operation is also very complex. In the process of the experiment, a number of cross-operating systems are required to be established. Configuration, software development, and script writing should be carried out on multiple operating systems to realize the transmission of data and files in several operating systems, improving the difficulty of operating embedded systems. It is difficult for students to get a better practical effect in a limited time.

The distributed file system is used to solve a series of problems in the teaching of embedded systems. Two embedded image teaching systems based on ARM technology are built: single machine mode and networking mode. Finally, the teaching system is applied and evaluated in the I/O experiment.

2. Traditional Embedded Image System Design Based on Arm Technology

2.1. Overall System Design

An embedded image processing system is proposed, combined with ARM core components. The overall design of the program, including the image transmission module and the SD card interface control, is shown in Figure 1 [11].

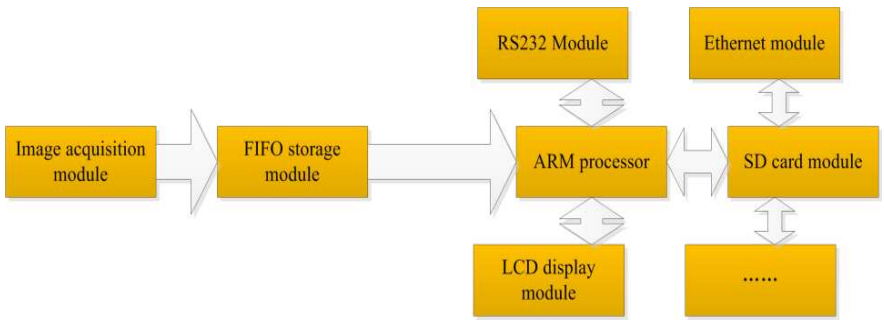

Figure 1. System overall design scheme

In the overall design of the system, combined with the FIFO module in ARM, the image data can be acquired. The image should be effectively dealt with, to achieve human-computer interaction process. Serial and Ethernet communication should be made, so that the image can be stored in the SD card.

2.2. System Hardware Design

In the design of system hardware, the S3C44BOX image is actually to deal with the application process of the module. Combined with the high price of the basic micro controller, an effective solution can be made [12]. In the application process of the ARMTTDMI kernel, the whole static design is fully realized, and the effectiveness of the cost control is achieved. The design of bus structure should be set up with SAMBAII. And the ARM7 system is used as a processor to extend the LCD module.

The application process of the S3C44BOX image processing module should be combined with the basic micro controller of the high price, so as to do the effective solution. In the process of the application of the ARMTTDMI kernel, the whole static design should be fully realized to do a good job of cost control. The design of bus structure should be set up with SAMBAII. And the ARM7 system is used as a processor to extend the LCD module [13].

Figure 2. Software design flow chart of image processing system

2.3. Realization of System Design

The design of image information processing system ARM and embedded technology can be realized. Combining with the image processing system, in the process of image processing, BMP bitmap file header information can be added. According to the BMP format file, an effective

reading should be made. The application process with the trademark pattern, the reasonable collection of the original image should be paid attention to. After the image grey stretch processing, threshold segmentation should be carried out, so as to find the position of the pattern.

3. Design of Embedded Image Teaching System Based on ARM Technology

The embedded experimental teaching platform which is built in this paper is an embedded Linux development platform based on PX270 processor [14]. The core board and the bottom board are constructed as shown in figure 3. The construction of the core board mainly consists of the following devices: PX270 embedded processor, the main frequency of which is up to 380MHz; 64 RAM MSD, mainly used for the dynamic storage system; Nor Flash 32M, mainly used for the static storage system; Loader Boot, mainly used for storage startup program. And there are Linux kernel image file and Linux application. The latter three constitute the JFFS2 file system. The bottom board is mainly composed of a variety of external ports and corresponding components, including USB interface, audio / video interface, memory card interface, camera interface, Ethernet interface, etc. A complete embedded system includes two core parts, the core board and the bottom board. The system has the advantages of low energy consumption, fast processing speed and small size [15-17].

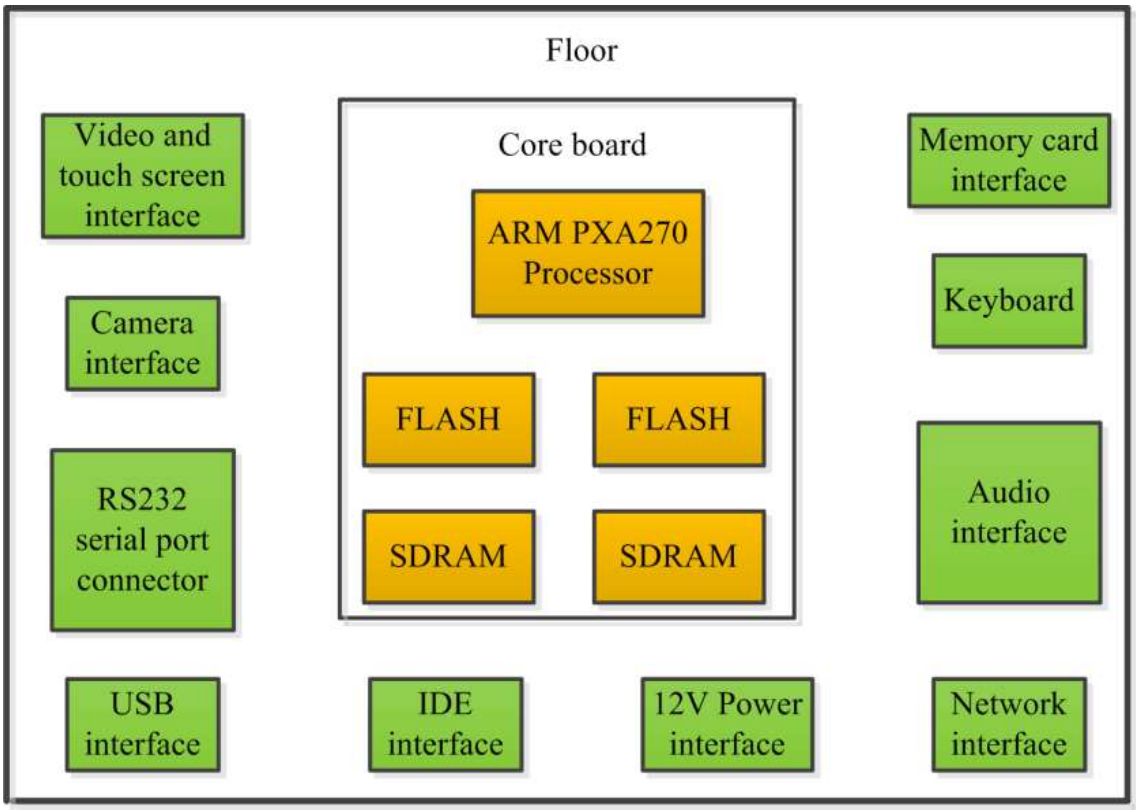

Figure 3. Structure of teaching experiment platform

Embedded system is a relatively closed system, so the software can be directly embedded in the system is less. On a general computer, the script should be written. And then through the cross compiler, in embedded systems, the script form that can be should be generated. Finally, through the file transfer or download, the script can be moved to the storage in embedded system. The environment of the cross system is mainly the environment of coding and debugging script. It is different from the environment in which the embedded application software is running. It is usually used in host / target mode [18] (as shown in Figure 4).

3.1. Standalone Mode

In a single mode [19], the computer and embedded ARM system form a whole. The computer runs the Windows system, and the Machine ware Virtual software is used to build a virtual machine. Virtual machine can separate the software from the system and run the embedded operating system and the corresponding program. At the same time, the Ubuntu system can be run in virtual machine system. By virtue of the virtual machine, XP Windows's system and Ubuntu system can establish an exchange directory, thus achieving the file exchange between the two systems. The virtual network adapter of the Ubuntu system is connected with the actual network card of the XP system, so as to promote the network connection between the two systems. In the end, the system environment and the decoding environment of Ubuntu

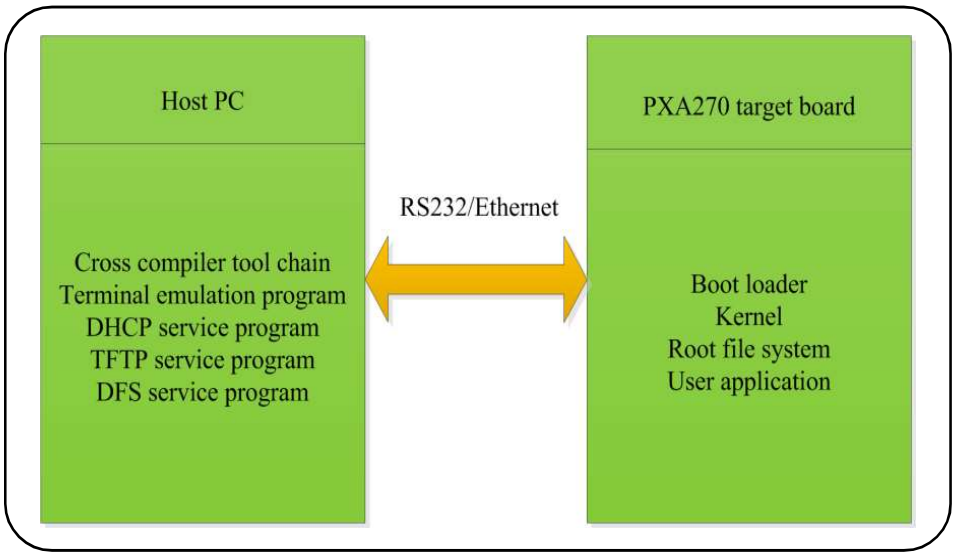

Figure 4. Cross development environment

system are established. According to this, in the two systems, the file, the program can be implemented. At the same time, students can also be able to carry out the development of software.

With ARM9 architecture S3C2440 processor as the core, ARM development board has USB, network cards and other functions. After installing the embedded Linux system on the ARM9, the program can be run on the ARM development board. Through the USB serial port, the computer and ARM development board can transfer procedures, documents, etc. At the same time, the computer can directly output commands to the development board, and immediately, the development board will be able to execute the command. Minicom is a tool for communication in the computer Ubuntu system. Through the Minicom, the computer can enter the corresponding commands, and operate on the Linux, and the results of the operation of the program can be observed through the ARM development board. In addition, through the network cable, the computer and the ARM board can realize the connection. When in the same IP address network, communication, file transfer, and resource sharing can be carried out between computer and ARM board. The development environment of the single machine mode is shown in figure 5.

DFS (DistributedFileSystem) refers to that, the physical storage resources in file system management are not necessarily directly connected to the local node, which can be connected to a node by a computer network. The design of distributed file system is based on client / server mode. A typical network may include multiple servers for multiple user access. In addition, peer to peer characteristics allow a number of systems to play the dual roles of the client and server. At the same time, the DFS file system also includes the server system and the client system. DFS server system is mainly related to the shared directory, and the DFS client system is the manager map directory. When the client is on a visit to mount a directory, through the DFS service, the client can directly access the shared directory server.

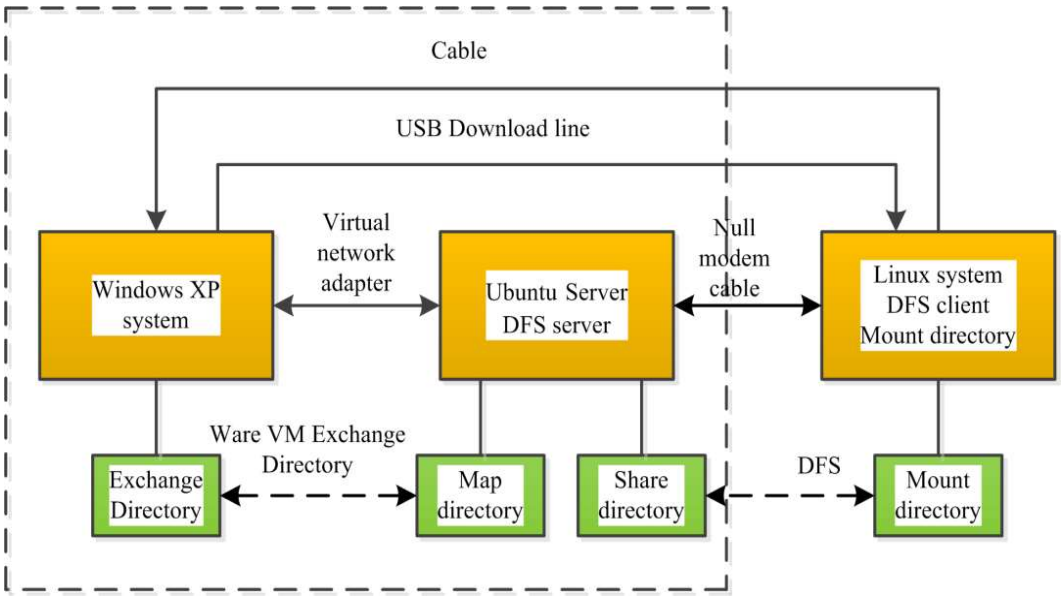

Figure 5. DFS single development model architecture

In stand-alone mode, through the DFS approach, the computer and the AMR development board achieve the transfer of files and scripts. The computer system Ubuntu DFS server is to manage the shared directory, and DFS client management mount directory. Through the DFS service, ARM development board mounted directory can be successfully mounted to the computer Ubuntu DFS shared directory. Through the communication between client and server, the direct mapping between the mount directory and shared directory can be established. There is no need to copy files, scripts, and other cumbersome procedures to the ARM development board. Through the DFS system, the sharing of the resources of the two systems can be realized, which greatly facilitates the preservation and modification of the file, and improves the system debugging and the efficiency of the experiment.

For the following configuration, Ubuntu system and ARM development board can open the DFS service function [20]:

Step 1: The Ubuntu system is logged on with root, and then /etc/init.d/iptablesstop is input at the terminal to close the firewall;

Step 2: In the Ubuntu system terminal, gedit/etc/exports is input to edit the file exports, and the directory root_DFS is set as the shared directory: /opt/EmbedSky/root_DFS* (RW, sync, no_root_squash);

Step 3: In Ubuntu system terminal, the command gedit/etc/sysconfig/network-scripts-ifcfg-eth0 is entered. And the Ubuntu system IP address is modified, so that IP address of WindowsXP, Ubuntu and ARM development board can be in the same network;

Step 4: In the Ubuntu system terminal, the /etc/init.d/networkstart command is entered to open the DFS service of the Ubuntu system;

Step 5: The Ubuntu system minicom tool is used to enter the ARM development board. In the Linux ARM development board, the new empty directory can be established as Mount directory;

Step 6: In the development board, the command is entered: mount-t DFS 192.168.1.X:/opt/EmbedSky /root mount _ DFS /DFS _ client - onolock, and 192.168.1.X is the Ubuntu system IP address. DFS_client is the new empty directory.

In the design of the system software, the first step is to conduct a preliminary preparation and design in the Ubuntu system of the computer itself, so as to prepare for the new ARM system architecture of the program documentation. The second step is to transfer and copy the preparation of a good document procedure, which can be put into the share directory of DFS server. After that, in the original preparation system, the ARM system should be re-entered. Through the mount directory, it can be run, which can be accessed in the DFS server, so as to achieve the purpose of the test. Then, the development software can be implemented under the ARM architecture. The shared files in the DFS server can be opened directly, thus further executing the program [21].

Through the above method, the software developed by computer and ARM architecture can be shared. Its share is the amount of the server in the DFS. When the students modify their source code and re compile the source code, the computer's shared files can be directly operated. There is no need to make a separate setting, so that students can more quickly rewrite their own source code. And a series of problems generated by a number of changes in the source code can be reduced. In ARM, students can directly run the shared documents in DFS to reduce the complexity of the experiment, so that the process is simplified and easy to learn.

3.2. Network Model

Network mode is the network expansion of the single mode, which refers to the learning unit in series and combination. Through the data network and the internal information network, a new connection and architecture (Figure 6) can be carried out, so as to get an experimental internal LAN [22]. Using the switch, the exchange of the experimental data can be carried out. The switch is connected with the campus network and the World Wide Web, so that students can use the network cable to write good program files in or out of schools. Through the DFS network format, and in the ARM development process, the preparation and use can be carried out, thus reducing the tedious places in the preparation, open and copy. So the efficiency and accuracy of the software are greatly improved.

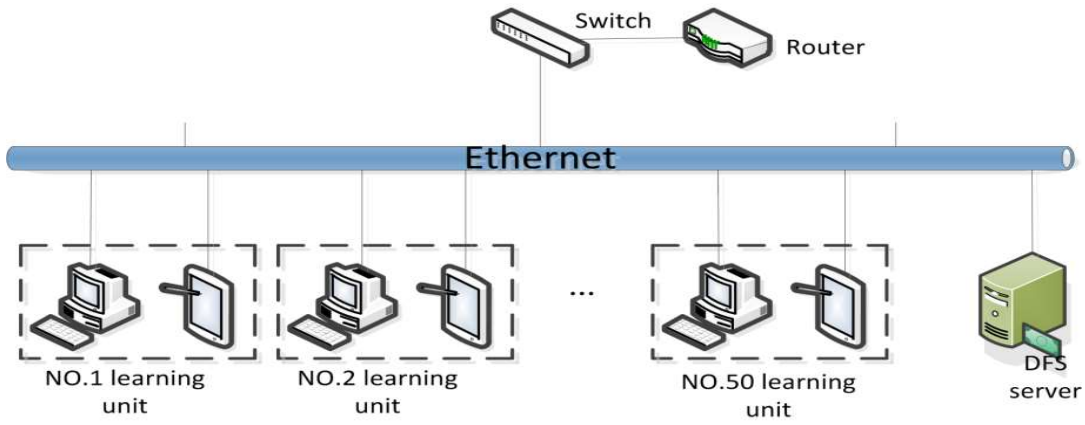

Figure 6. DFS network development model architecture

Through the number of procedures, the above network model can be carried out the individually numbered on the learning unit and ARM development system. At the same time, according to the number, the school network IP address can be given, so that each learning unit can carry out the above operation and will not leave out any learning unit. If the learning unit number is X, the IP address of the computer XP Windows can be set to 192.168.1.X. The IP address of the Ubuntu system is set as 192.168.1. (X+100), and the IP address of the ARM development board is set as 192.168.1. (X + 200). The entire above equipment gateway is set as 192.168.1.1, and the subnet mask is 255.255.255.0. Using the above operation, it can be ensured that all the learning units can enter the same local area network. At the same time, in the network 192.168.1.1, the router can be re set. At the same time, in the campus network, a separate server can be set, so as to use the network cable and complete the operation. The role of the server is to summarize and organize learning materials, which are issued and published through the server. The above network planning can be expressed in Figure 7.

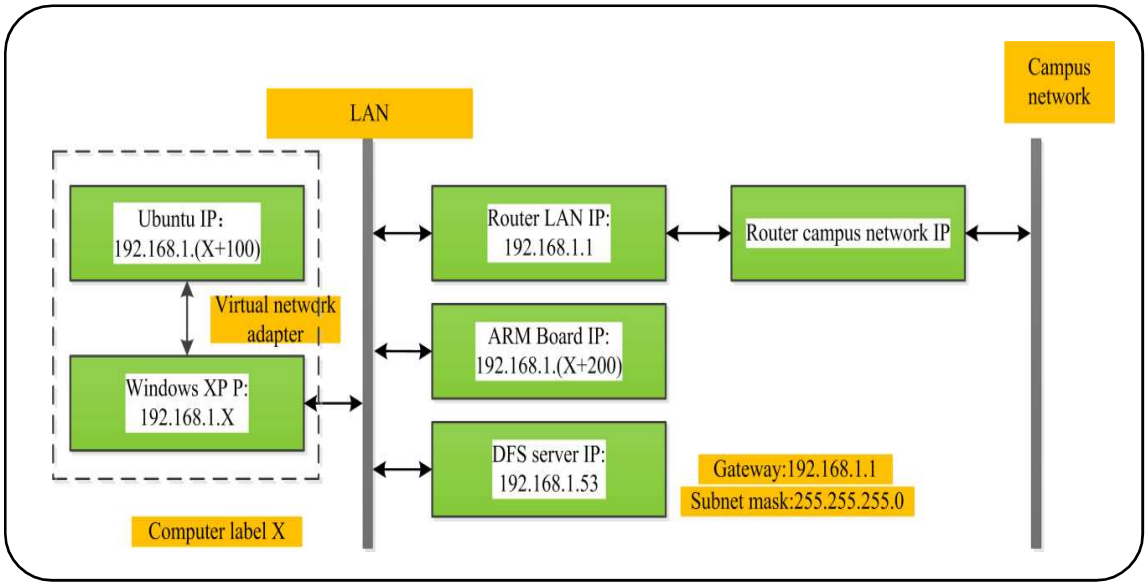

Figure 7. DFS network development model IP configuration diagram

The establishment of the network structure allows students and teachers to get a common return. Therefore, it is necessary to save a lot of the preliminary preparation time that the students need to adjust and develop the software program. Before the class, the teacher can carry out the embedded development on the required procedures, and students can directly run the program documentation by DFS, thus saving a lot of time. And the teacher can control each student's computer through the DFS server. By this way, the completion of the experiment in class can be understood. At the same time, the completed part can be fully commented, thus strengthening the communication between teachers and students in class. Therefore, the training effect of the experiment can be further improved [23].

4. Evaluation

The Operation Flow of the Open Linux Teaching Platform is Shown in Figure 8:

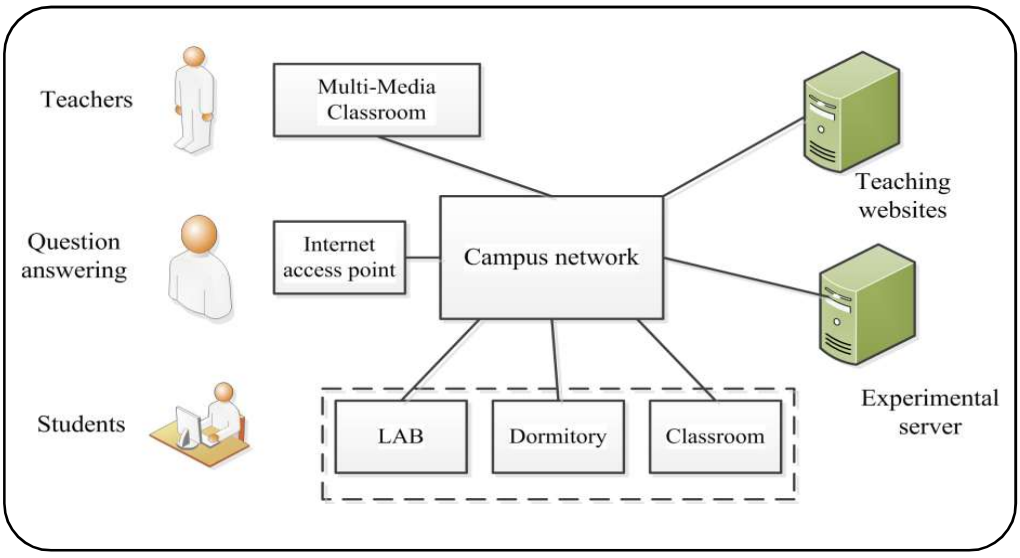

Figure 8. Operating diagram of ARM experimental teaching platform for embedded system

During the class, the teacher can use the multimedia equipment in the classroom to carry on the campus net's login, so as to enter the set of good web site to find the required teaching software. In the course, the teacher can use the software to carry out lectures and presentations. In the course of the class, the teacher can login the website at any time in order to facilitate the relevant teaching experiments.

Students can log on the site in the laboratory or by other means, such as in the dormitory or in other locations, so as to achieve the learning and simulation of the experiment at any time and place. The effect of the experimental study is not much different from the effect in the laboratory.

The site can also interact with the Q & A. Through mobile or fixed end, the answer can log on the site, and answer any questions raised by students, so as to realize the real time to solve the problem, real-time communication, and fully communicate with each other.

5. Experimental Analysis

5.1. I/O Experiment

The experimental procedure [24, 25] is used to test whether the I/O port of AT91RM9200 is working properly. At the same time, it is also the first step in the process of learning embedded processor. Through the I/O port experiments, students can understand the basic idea of embedded system programming: control processor pin level.

The main content of this experiment is: the I/O port is set to the output, and connected with the LED lamp. When the mouth is low, lights will be lit. Another I/O is connected to the switch, when the switch is closed, the I/O port is low.

In this experiment, there are groups of 2 I/O port in AT91RM9200. At the same time, they are multiplexed with the peripheral modules. Managed by the PIO module, in each group of I/O, the register has a corresponding I/O. In the experiment, the 1 of B port I/O port is set as input and has internal pull up, and the second pin is set as output (hereinafter referred to as PIOB1 and PIOB2).

Firstly, the PIOB1 and PIOB2 in the PIO_PER should be set. And the corresponding bit of PIO_ODR and PIO_OER should be set as inputs or outputs. Then, if the PIOB2 is set to low level, a LED lamp can light up. On the contrary, the lights go out. Finally, the output of the I/O port can be detected by reading the corresponding bit in PDSR. A bit to 1 indicates that the I/O port is high. On the contrary, it is low. The program repeatedly tests the state of the switch on the PIOB1. When it is high, the LED of PIOB2 will go out. When it is low, the light will light up.

5.2. Experimental Result Analysis

In the teaching method, in order to verify its effectiveness, an ARM laboratory is established to carry out a deep research on it. There are 50 students in the lab, and the experiment can be carried out at the same time. In the course of the experiment, the teacher will firstly explain the experimental process for the students in PPT, and explain the focus of learning at the same time. In the course of the experiment, the students have finished the experiment. In DFS system, the experiment is carried out on the system design, translation and other work, and can be carried out independently by the students to write and so on. At the same time, through the set of good procedures, the required test data can be found in the Internet. In the process of the experiment, through the DFS, the experimental class teacher can also detect each student's time, so that each student's learning progress and problems in the experiment can be obtained. And each student's different questions can be answered.

In the laboratory, 50 students independently complete the experiment. And in the establishment of the learning unit, the embedded environment should be written and built. And at the end of the experiment, the basic experiment of I/O is carried out. Through the investigation of the experiment, it is concluded that the system and the way of teaching can enhance students' autonomous learning ability, and can be carried out in person. At the same time, with the further understanding of the embedded system, students' independent innovation and R & D capability is been significantly enhanced.

6. Conclusions

In this project, it is a new type of ARM system platform. On this platform, the shared documents in DFS can be run directly. The embedded system platform is a new development platform. In a university in Sichuan to create a laboratory experiment, and then the further promotion and application are carried out. From the feedback, through the platform, the test time needed by students is greatly reduced, thus fully mobilizing students' autonomous learning ability and independent innovation ability. At the same time, in the process of writing this platform, students can understand and operate the system deeply. In all the student feedback, the conclusion is that the system has already achieved its original purpose. At the same time, the system can be modularized and functional, and it is very cheap.

In the process of system design, there are still some problems, for example, its performance and the accuracy need further improving, and its own function also needs expanding. And for the C language, the development and utilization of Linux system can be improved. Thus, the students can carry out independent innovation and adjustment, in order to obtain better learning results.

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