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Design of Mobile Learning System for Courses of Computer Science and Technology

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Abstract. In recent years, mobile learning system is increasingly applied in colleges and universities due to its promising capability. This paper proposed a design of mobile learning system for courses of computer science and technology. The architecture was described, and the detailed scheme of the system was given including server and client solution. The system adopted Client/Server structure, and it supported Android and iOS operating systems. The relationship of each level and the data structure of each model were designed according to the business logic. Consequently the client program was developed based on real time video transmission protocols of RTP/RTCP/RTSP. The main functions of mobile learning system included curriculum center, teacher-student interaction, assignment and project. This design provided a learning platform for the students majoring computer science and technology. Using hand-hold mobile terminal devices, students can study courses anywhere and anytime through video, voice, picture, text and other media.

1. Introduction

Mobile learning is a modern method that enables students to learn anywhere and anytime with the help of mobile devices. Mobile computing devices can effectively present learning video, audio and text combined by hyperlinks, and provide two-way communication between teachers and students[1]. It can also effectively provide teacher-student interaction, and student-student interaction by means of mobile interactive application [2].

The popularity of mobile learning depends on the increasing use of mobile learning devices. In recent years, mobile terminals have become popular among college students, even people in remote areas can use them for mobile learning [3]. Computer courses are complicated and difficult, requiring repeated learning and practice. Moreover, some students lack basic knowledge of computer and need extra classes. It is hard to achieve good outcome only relying on traditional teaching way[4]. Accordingly mobile learning is the best solution to these problems.

Therefore, this paper designs a mobile learning system based on Client/Server architecture for teachers and students majoring in computer. The server implements data services and business logic, and the client supports Android and iOS operating systems to realize the presentation layer function. On the one hand, it provides a platform for teachers to try new teaching methods; on the other hand, it encourages fragmentation learning, autonomous learning and interactive learning, which is of great significance for students.

2. Design of mobile learning system architecture

Mobile learning system requires high computing power for students to interact with teachers. Because of the limited computing resource of terminal hardware devices, we use C/S structure to put complex
operations of learning system on the server, while mobile phones are only used for interaction and data display (Fig. 1). The structure of mobile learning system is composed of presentation layer, business logic layer and data access layer. The business logic layer and data access layer are on the server side, while the presentation layer is on the client side. In our system, the data access layer inserts, deletes and modifies the following four types of databases: course video database, user information database, course assignment database and learning interaction database. Business logic layer receives data from presentation layer and transfer it to data access layer after logical calculation. Business logic layer includes video course module, course interaction module, assignment management module and user management module. The presentation layer is the interface displayed to the user and interacting directly with the user. It accepts the user's request and returns data, and provides the client with access to the application. The component of presentation layer is based on Jersey framework, and Jersey is a Representational State Transfer (REST) style network framework. The system forwards HTTP requests to the corresponding presentation layer objects and returns the results to the client in JSON interchange format[5-6].

![Figure 1. Architecture of mobile learning system](image)

3. Design of the server

Server is an indispensable part in mobile learning system, which involves a series of software. In the system, Apache is used as web server, JAVA is used as development language of the server, and Oracle 11g is used as database management system. The architecture of Oracle database is divided into two parts: database structure and instance structure. As shown in Fig. 2, the database structure includes physical storage structure and logical storage structure.

We planned five data files, including course information database, course video database, user basic information database, assignment & project database, and user interaction database. The structure of data stored in the database depends on the logical storage structure of the database. Logical storage unit is divided into table space, segment, area and block. Table space is the largest logical storage unit in the database, which is directly related to physical structure data files. Course information database includes course basic information table and course video list table. Video course database includes video information table, video file table and video-course association table. Assignment & project database includes assignment information table, assignment table and assignment answer table. User data database includes user information table, authorization & expiration table. Interactive database supports idea exchanges between teachers and students in course learning, including interaction record table and Frequently Asked Questions (FAQs) table.
4. Design of the client

Android and iOS operating systems are the two most widely used mobile operating systems. The market share of Android and iOS is more than 95%, and Android platform accounts for 52.2% and iOS platform for 33.4%. Android is favored by major mobile phone manufacturers because of opening source code, while iOS has a large share in the high-end market with advanced technology. Based on the above facts, this paper develops a mobile learning system supporting both platforms.

4.1. Design of the iOS client

Firstly we developed a mobile learning client for iOS system. The architecture of iOS is divided into four layers from top to bottom: Cocoa Touch layer, Media layer, Core Services layer and Core OS layer. (1) Touch layer provides a variety of common frameworks for application development, and most of them are related to the interface. Essentially, it is used for user's touch interaction on iOS devices. (2) The media layer provides audio-visual technology in applications, such as CoreMedia, Media Player framework, AirPlay framework for audio and video transmission, etc. (3) Core service layer provides basic system services to applications, such as accounts, advertising, data storage, network connectivity and geographic location frameworks. (4) The core operating system layer directly interacts with hardware devices. It includes memory management, file system, power management and some other operating system tasks. We operate the hardware through the interface without having to deal with this layer.

Our mobile learning system is developed using Mac OS X + Xcode. iOS can only be developed on Mac OS, which is the exclusive operating system developed by Apple for Mac products. Xcode is an integrated development tool (IDE) running on the operating system Mac OS X. A unified interface design makes it possible to code, test and debug in a single window. The iOS application of mobile learning system is developed by Objective-C. It is an object-oriented tool based on C language to
develop iOS applications. The code is compiled into machine instructions by GCC compiler[7]. The configuration of software and hardware for development platform is as follows:

- Hardware system type: MacBook Pro 865
- Operating system version: OS X, 10.12
- Development environment: Xcode 6.2

4.2. **Design of the Android client**

We also developed a mobile learning client program based on Android system. Android system architecture, like that of other operating systems, uses a hierarchical architecture. It is divided into four layers: application layer, application framework layer, system runtime layer and Linux kernel layer.

1. Application layer provides a series of core application packages, including client, SMS short message program, calendar, map, browser, contact management program, etc. All applications are programmed in JAVA language.

2. Application Framework is the main tool for us to develop software. The application framework layer includes ten parts: activity manager, telephone manager, resource manager, location manager, view system, package manager, window manager, content provider, notification manager and XMPP service. It simplifies the component reuse: any application can release blocks, and any other application can use the modules.

3. The Libraries layer supports the important Android functions through c/c++ libraries, such as the support of database provided by SQLite, the support of 3D drawing provided by OpenGL library, and the support of browser kernel provided by WebKit library. In addition, the Android runtime library provides some core libraries to enable us design Android applications in JAVA language.

4. Android system is based on improved Linux kernel. The kernel layer provides drivers for hardware, such as display, audio, camera, Bluetooth, WI-FI, power management, etc[8].

We build Android development platform and use Java write applications. The tools and their versions are as follows:

1. JDK 1.7 is the Java Development Toolkit (JDK). It includes many Java tools and Java class libraries, which are frequently called when developing applications.

2. Eclipse IDE for Java Developers, which is an integrated environment for Java applications and Android development.

3. Android SDK, which provides API libraries for developing Android applications and tools for testing and debugging.

5. **Data interchange between client and server**

5.1. **JSON data interchange format**

We interchange data between client and server of mobile learning system with lightweight software tool JSON. JSON is based on strings and has excellent read and write performance. JSON uses Javascript grammar to describe data objects, but JSON is independent of programming language and operating system. JSON parser and library support many different programming languages. Another important reason for adoption of JSON is that both Android and iOS encapsulate JSON parsing libraries for developers to use. Android's JSON reads binary stream returned by the server and converts it into text[9]. IOS parses JSON data in traditional way. It determines whether the data is the known data type, and then obtains the corresponding value in JSON data.

5.2. **Multimedia data transfer protocols RTP, RTCP and RTSP**

In our mobile learning system, the core function is to transfer curriculum video. The most important features of video are the large amount of data and the high requirement of real-time, so we use three protocols of RTP, RTCP and RTSP to do it (Fig. 3).

Real-time Transport Protocol (RTP) is a network protocol for processing multimedia data streams on the Internet. It can transfer real-time streaming media data in one-to-one (unicast) or one-to-many (multicast) manners. RTP does not provide reliable transport mechanism for sequential transmission of data packets, nor does it provide traffic control or congestion control. Therefore, there is no delay caused by timeout detection for lost packets. And for discarded packets, the upper layer can selectively
retransmit them according to their importance. For example, for I frame, P frame and B frame data in video, whose importance decreases in turn. We do not retransmit when B or P frame of the video is lost in the case of bad network condition. In this way, it ensures real-time data transfer although there may be short blurred pictures in the client.

RTCP is a Real-time Transport Control Protocol. The main function of RTCP is to monitor the quality of service, feedback information and synchronization between media. During the RTP session, the participants periodically transmit RTCP packets. RTCP packages contain statistics such as the number of sent packets and lost packets, so participants can use this information to dynamically change the transmission rate or even the type of payload. The combination of RTP and RTCP can optimize transport efficiency with effective feedback and minimal overhead, so they are especially suitable for real-time transport of multimedia data on the network.

RTSP provides streaming media operations such as playback, pause, fast forward, etc. It describes control messages, operation methods, status codes, and interaction with RTP. The session process of RTP, RTCP and RTSP is as follows: when an application establishes an RTP session, the application needs a network address and a pair of ports, one for the RTP and another for the RTCP [10]. RTP data uses even UDP port, while corresponding RTCP package uses adjacent odd UDP port.

Figure 3. Multimedia data transfer protocol RTP, RTCP and RTSP

6. Conclusion
This paper designs a mobile learning system for teachers and students majoring in computer science and technology. The system adopts C/S structure, and it supports Android and iOS systems. The main functions of mobile learning system include curriculum center, teacher-student interaction, and assignment & project.

(1) Curriculum center
The curriculum center is organized according to courses of computer specialty, including operating system, computer composition principle, computer network, database principle, software engineering, programming language courses, etc. Considering the characteristics of mobile learning using fragmented time, every course is not organized according to chapters, but provides videos based on knowledge points. Each student can play video on demand anytime to meet their own needs.

(2) Teacher-student interaction
Extracurricular answering is an important part of teaching work. Students can ask questions for the course, teachers will give timely answers, and teacher-student interaction can take a variety of media forms: video, picture, voice, text and so on. Questions and answers are online through the system, and other students can browse the question and answer.

(3) Assignment and project
The system provides assignment and project for each course to deepen students' understanding of knowledge. What’s more, teachers can understand the outcome of students' learning through assignment completion.

(4) Learning resources
The system can recommend documents, books, software tools and important news related to the teaching of computer specialty, which are the assistant resources of mobile learning system.

This paper detailed the architecture and technologies of the mobile learning system. It can provide a learning platform for the students majoring computer science and technology, which is of great significance for them to learn using fragment time.
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