Design and Implementation of Mobile Learning System Based on Wireless Communication Technology

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Abstract. Due to the lack of comprehensive definition of learning resources in traditional mobile learning systems, the transmission efficiency of learning resource packets is poor. Therefore, a mobile learning system based on wireless communication technology is proposed. In terms of hardware, it adopts SOA technology framework, optimizes the overall system architecture, adds wireless communication environment middleware, and optimizes the system communication interface and resource reading channel. In software aspect, MySQL database is established to store learning resources, and load balance control theory is used to improve the storage density of resource information. The experimental results show that the design system improves the data throughput, reduces the data transmission delay, and the actual application effect is better.

Keywords: Wireless communication · Mobile learning · Hardware design · Software design

1 Introduction

At present, all kinds of scientific knowledge show explosive growth at the speed of exponential level. Therefore, learning through traditional education methods cannot meet the demand for knowledge at this stage. In such an environment, mobile learning with wireless communication technology as the main transmission carrier emerges as the times require. Mobile learning is a kind of learning method that breaks the geographical restrictions and makes full use of mobile terminal equipment and wireless network communication technology. Nowadays, domestic research on mobile learning is relatively perfect. Tsinghua University and Beijing Normal University, with the support of the Ministry of education, have carried out mobile learning application research projects and developed relevant mobile learning platforms running an open operating system, with perfect user interface and powerful expansibility, can easily install and uninstall application software. Through 4G, 5G and intelligent mobile terminal devices, rich multimedia content teaching has become a reality.

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Wireless communication technology is developing rapidly. The current mainstream standards are 4G and 5G mobile communication technologies, which can be used to simultaneously transmit images, audio, video and other content. Mobile terminal equipment has also changed from a functional mobile terminal device to a smart mobile terminal. Equipment, its processing capacity, storage capacity, etc. are greatly improved. Based on the above theory, this paper designs a mobile learning system based on wireless communication technology.

2 Design Method of Mobile Learning System Based on Wireless Communication Technology

2.1 Mobile Learning System Hardware Design

2.1.1 Design the Overall Architecture of the Mobile Learning System

Optimize the system architecture, adopt SOA as the core technical framework, use service middleware as the operating support, base on the basic database, and use the basic service as the center of the system architecture. The overall architecture is divided into application layers from top to bottom. Service system layer, middle component layer, basic resource layer. Use the basic resource layer to provide various resources for system development, including basic data and information database, control basic data not to be affected by development, describe learning resources in the form of words, programs, graphics, block diagrams, files, etc., so that basic data Different forms are stored in the resource layer [1]. In the middle component layer, the component interface standard specification is defined, the computing component and the presentation component are integrated through the multi-layer message bus, and the component entity and runtime state are managed through the lightweight component integration framework, so that the information between the components is balanced. Functions interact to provide core services required at runtime, including user management, security operations, etc. The middle component layer is divided into message middleware and integrated components. Through integrated components, component operation management, component access, environmental information integration and component registration are realized, and the development, operation and wireless communication of components are shielded, which provides efficient communication and comprehensive integration for upper network communication. Network communication realizes functions such as message transmission and time unification, as well as special protocol conversion, general information transmission and communication agent [2]. Use the service system layer to provide services for the application layer, and finally use the application layer as a service consumer in the system architecture to provide support for the development of supporting tools, and display information processing products to the operator, integrate interface components, including various business displays, Non-real-time information display, real-time information display. The overall architecture of the learning system is shown in Fig. 1.

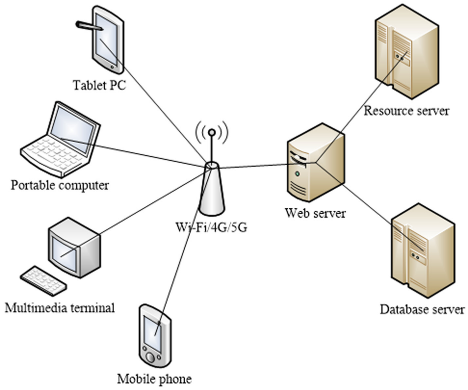

Fig. 1. Overall architecture diagram of the learning system

As shown in Fig. 1 above, the client of mobile learning system mainly runs various kinds of mobile terminal devices, such as mobile phones and tablet computers. Each learner has his own mobile terminal equipment. After inputting identity information in the client program, the learner connects to the server through wireless communication network for verification. After passing the verification, the client program can be used to request the required learning resources or interactive activities. The server side of the mobile learning system is mainly responsible for verifying learner information, managing learning resources and processing interactive information. The server-side program is developed by using the structure mode, and is deployed and run by Apache tomcat, and the storage of user information and learning resource information is realized [3].

So far, the overall architecture of the learning system is designed.

2.1.2 Design the Functional Structure of the Mobile Learning System

The functions are distributed on the client and server. The user establishes a connection with the middleware through COM/DCOM. The system receives the request through the web presentation layer, obtains learning resources from the database, processes the learner's request according to the coding business rules, exchanges with the data collector through the middleware, and returns the processing results to the web presentation layer, and finally sends the data to the database. The block is shown in Fig. 2:

The server side of the system provides support for the management of mobile learning course resources. It helps scholars enter their user name and password on the system login page to perform login operations. After successful login, they enter the main interface to help scholars to conduct courses for which they are responsible. The chapter catalog management can also manage the learning content of the existing chapters. Finally, you can upload the corresponding learning materials and reply to the inquiry questions sent by the learners from the client. The supporter module provides supporters with necessary support for the classification and management of mobile learning courses. Supporters enter the user name and password to log in. After the login is successful,

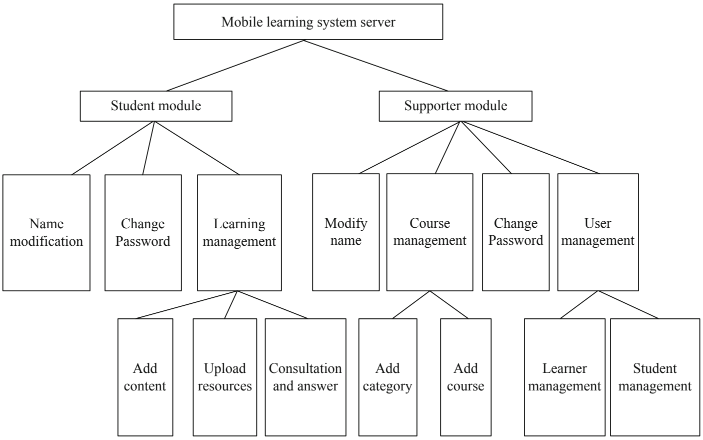

Fig. 2. Server-side functional structure of mobile learning system

they enter the main interface, create, modify or delete courses as needed, and perform courses classification, convenient for learners to search while studying. Supporters are also responsible for managing the related information of the assistant scholars, assigning the courses that the assistant scholars are responsible for, and dealing with the problems feedback from the learners. According to the analysis of the learner's role and behavior, the mobile learning system client program is designed into three modules: login module, online learning module, and support service module. The specific functions are shown in Fig. 3:

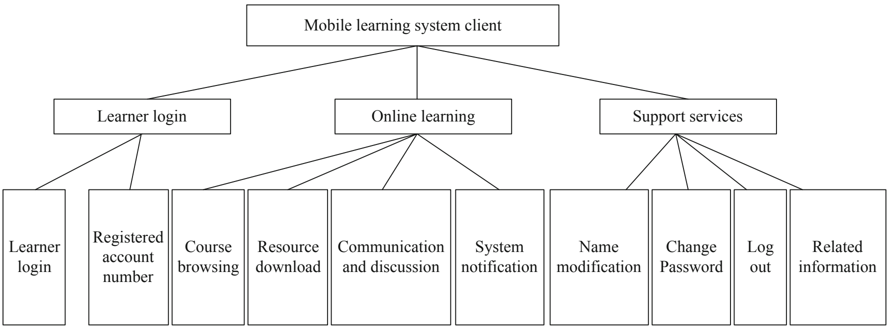

Fig. 3. Client function structure of mobile learning system

After login, the user can enter the next operation according to the user's name and user's needs. After entering the learning module in the main interface, learners can select the functions to be realized according to the menu icon, including course browsing, resource downloading, communication and discussion, and system notification. Course browsing allows learners to browse the course content online, download resources to provide auxiliary learning resources for learners, exchange and discussion provide support for learners' interactive activities, and system notification can send system notification information to learners. Learners can modify the user name and login password through the support service module, log off and return to the system login module, and view the relevant information of mobile learning system client.

So far, the functional structure of mobile learning system is designed.

2.1.3 Optimizing the Communication Interface of Mobile Learning System

In the middle component layer of the overall architecture, the host infrastructure middleware, which is a self-adapting communication environment, is used to optimize the network interface of electronic information and simplify the system communication process. In the underlying network communication, add self-adapting communication environment middleware, receive and process the target information of network transmission, give full play to the event-driven characteristics of network transmission, use the self-adapted communication environment to provide public interfaces, and process I/O events of network connections, So that the system communicates between interfaces through middleware [4]. The communication interface adopts the UDP protocol to collect data and monitor I/O events, so that the self-adapting communication environment uses the Wrapper Facade mode to receive real-time rebroadcast data. Call the registration object of the self-adapting communication environment middleware, set the multicast address and port number, make the registration object join different multicast addresses, keep the port number the same, and receive electronic information data. After the data is received, the network message is processed through the hook method, the network message protocol identification is analyzed, different types of messages are distinguished, and the electronic information data is finally updated. When there is a target message that has not been communicated for a long time in the network transmission, use the adaptive communication environment reactor to register I/O events to determine whether the message arrival time is overtime. When it is judged as a timeout event, it will be based on the last received position, automatically calculate the current position of the message, locate the target message, and transfer it to the network message interface after receiving it again to process the information data [5]. Optimize the communication circuit so that it can transmit video images and meet the volume limit of the inspection device. The optimized communication interface circuit is shown in Fig. 4.

The power supply voltage is transformed into a voltage suitable for the operation of the device, and the internal information of the mobile communication device is collected in real time. Its communication mode adopts multiple monitoring display, selects LAN to connect mobile terminal, establishes WiFi hotspot in the lower computer, establishes small LAN, and realizes multi terminal communication and other operations [6]. Then, the communication interface of the learning system is defined. Using programmable logic devices, it can store large capacity data. The pin definition of receiving interface is shown in Table 1.

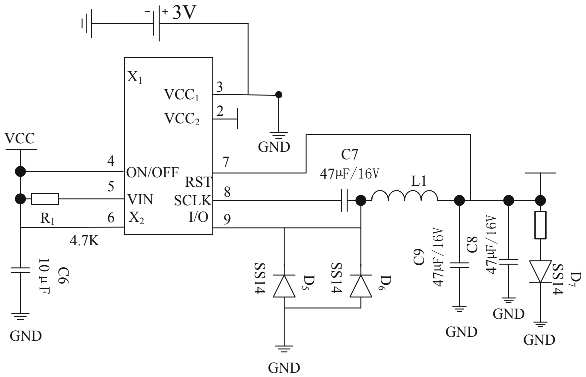

Fig. 4. Optimized communication interface circuit

Table 1. Definition of communication interface pins.

Pin number	Pin name	Features
2	MUTE	Backup data serialization signal output terminal
3	CD#	Backup data serialization signal input terminal
4	SDI#	The pin is grounded, and the output data serialization signal is enabled
6	AEC+	Detect serialized signal load
7	AEC−	High and low level conversion, directly output serialized signal
8	BYPASS	The pin is left floating to select the equalization effect of the output data serialization signal

As shown in Table 1 above, when the pin is at high level, the chip of backup memory works normally and directly outputs the backup data signal. When the pin is at low level, the chip is converted into a closed-loop feedback with series capacitors to eliminate the DC component of signal transmission and make the input signal enter into adaptive filtering. According to the signal difference regulated by the back-end DC recovery level, the gain and bandwidth of data backup memory are set to obtain AC coupled backup data input signal [7]. The optimized communication interface will provide a return loss for the network data, repair the distorted backup data transmission signal, and enable the mobile learning system to store multiple formats of backup data. In the storage process, the SD card storage mode of the lower computer is used to select the 4-bit data width, operate the communication interface, and set the read channel at the input end, as shown in Table 2:

According to the content of the above table, the learning resources are read, so that the optimization of the communication interface of the mobile learning system is realized, and the hardware design of the mobile learning system is completed.

Table 2. Learning resource reading channel settings.

Read signal	Description	Signal source
AWID/ARID	Identify the collected signal ID	Master/slave
AWLEN[7:0]/ARLEN[7:0]	Set the transmission length to 2, 4, 8, 16, and cyclically transmit data	Master/slave
WLAST/RLAST	Indicates the last transmitted data	Slave
BVALID	Respond to valid signals	Slave
WSTRB/RSTRB	Transmit unaligned data, 1 byte represents each bit	Master/slave
BREADY	Indicates that the inspection device can receive equipment acquisition signals	Master

2.2 Mobile Learning System Software Design

2.2.1 Design a Mobile Learning Resource Database

After the system hardware is designed, the system database is designed to record and store the mobile learning resources. Use the database relationship diagram to display the composition and internal connections of each entity data, use MySQL database to view each database table, and integrate with PHP/PERL and Apache, so that the database supports multi-threading and multiple connection methods [8]. Among them, MySQL database adopts the dual authorization mode of community edition and commercial edition to provide administrators with dynamic website technology. The main record data of the database is shown in Table 3.

Table 3. Learning system database.

Field name	Type of data	Data length	Field description
userId	varchar	11	Learner information form
Sett-status	varchar(50)	14	Help scholar information form
projectcode	varchar(50)	11	Course classification information table
areaname	varchar(50)	14	Course allocation information form
paymentplan	varchar(100)	64	Course information form
flowNum	varchar(255)	64	Course content information table
description	varchar(255)	11	Help scholar information form

As shown in Table 3, learners can access the databases within their authority on the premise of complying with GPL protocol. Using distributed technology, the MySQL database is customized and developed to support different requirements such as single point replication and cluster size, so as to meet the different needs of learners. MySQL database has better compatibility. The development of Linux+Apache+MySQL combination can realize the processing of tens of millions of data records [9]. Since learning resources are a key component, the learning resources stored in the database should be classified and standardized, and the following aspects are mainly defined: summary information mainly describes the identification and index of the resource; cycle information mainly describes the use cycle of the resource the content of the resource, such as the release time, effective time, and update status of the resource; the data information mainly describes the data format standard used in the learning resource, such as keywords, data types, and the language used; technical information mainly describes the technology of the resource attributes, such as resource format, production tools, usage guides, etc.; educational information mainly describes the pedagogical characteristics of the resource, such as the way the resource interacts, learning difficulty, and learning time; value information mainly describes the economic content of the resource For example, the copyright of the resource, the purchase price, etc.; the related information mainly describes the related information of the resource, such as the reference content of the resource, related resources, etc.; the annotation information mainly describes the review information of the resource, including the reviewer, the content of the annotation, the time of the annotation, etc.. Classification information mainly describes the classification of resources, such as keywords, tags, and languages of resources.

So far, the design of the learning resource database is completed.

2.2.2 Improve Storage Efficiency of Learning Resources

The load balance control theory is used to improve the storage density of learning resources in the database. According to the application environment of the learning system, a multi-user rule scheduling set is established to calculate the fitness function of resource information, which is regarded as the adaptive feature of resource information Set attributes are classified. The classification objective function x is as follows:

$$x = (t + 1)cTw\xi \tag{1}$$

In the formula, t is the storage overhead, c is the electronic information transmission threshold, T is the size of the information data rule set, W is the weight coefficient, and ξ is the transmission time length of the scheduling information [10]. For different types of resource information, storage nodes are set to maximize the information storage density, so that the storage space load is balanced, so as to meet the characteristic scheduling conditions. Distribute and output the scheduled resource information to obtain a feature subset of the redundant data, and then compress and process the redundant data, check the feature constraints of the remaining data, and obtain a large-scale storage distribution space structure. On this basis, according to the time sequence, the resource information is spatially reconstructed, the information data is distributed and reorganized according to the joint probability of the nearest neighbors, and the large-scale information flow is mapped to the phase space to obtain the optimal feature decomposition condition of the information. Finally, the feature set is output to realize the clustering processing of resource information, and several data blocks are obtained, and the data blocks are associated with the cache space area to improve the storage efficiency of learning resources.

So far, the software design of the mobile learning system is completed. Combining hardware and software design, complete the mobile learning system design based on wireless communication technology.

3 Experiment and Analysis

In contrast experiment, the designed system is taken as experimental group A, and two traditional systems are respectively taken as experimental group B and experimental group C. the transmission efficiency of the three groups of experimental learning resources is compared.

3.1 Experimental Preparation

Install JDK/JRE and install ADT plug-in in it. This plug-in provides learners with a powerful comprehensive environment for developing Android applications, using Java development language and SDK to develop mobile learning systems. The experimental data sets are text information learning resources, website learning resources, and multimedia learning resources. The college campus network is used as the test environment. The three groups of systems manage the learning resources in a unified manner. Students use mobile devices through unified dynamic users. Verify, access the access interfaces inside and outside the campus, share and download learning resources, the specific topology of the campus network of the college is shown in Fig. 5:

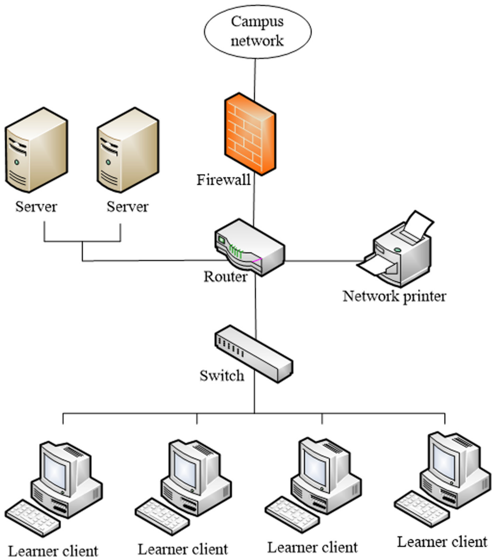

Fig. 5. System test network topology diagram

The experimental environment consists of two computers connected to the Internet through network equipment. One host runs WiniSCSI Target, which simulates iSCSI target, and acts as a storage device to send digital learning resources. The other host runs Windows iSCSI Initiator as a resource receiver. The connection mode is set to routing mode, the computer CPU is Intel F4600, the hard disk is SATA 500G, the memory is 2G, the main frequency is 5 GHz, and the access network download speed is 700 KB/s.

3.2 Experimental Result

3.2.1 The First Group of Experimental Results

Using iometer test tool, open the disk manager on the test host, get a new disk, that is, the learning resources accessed by the learner client, read data from the disk and write data to the disk. Change the size of the learning resource packet to control the data block of sharing request between 16 kb and 1024 KB. Test the throughput of the mobile learning system when the learning resources are read 100% on the disk. The experimental results are shown in Table 4.

Table 4. Comparison results of 100% read operations.

Shared data block size (KB)	Experimental group A throughput (MB/s)	Experimental group B throughput (MB/s)	Experimental group C throughput (MB/s)
16 KB	2.01	1.82	1.81
32 KB	4.73	4.08	3.95
64 KB	6.09	5.13	4.95
128 KB	7.45	6.57	6.29
256 KB	9.01	7.98	7.56
512 KB	9.67	8.56	8.16
1024 KB	10.53	8.63	8.26

According to the data in the above table, the throughput of experiment group A can reach 10 MB/s when 100% read operation is performed, while the throughput of experiment group B and experiment group C is only within 9 MB/s. Compared with the traditional system, this design system Throughput has improved. Convert file server virtualization to storage virtualization in disk linear mode, synthesize a logical disk in a linear manner, perform 100% write data, that is, when uploading learning resources, detect the throughput of the three systems in this case, and compare them. The test results are shown in Table 5.

Table 5. Comparison results of 100% write operations.

Shared data block size (KB)	Experimental group A throughput (MB/s)	Experimental group B throughput (MB/s)	Experimental group C throughput (MB/s)
16 KB	1.79	1.63	1.43
32 KB	4.02	3.82	3.67
64 KB	5.08	4.88	4.82
128 KB	6.35	5.87	5.63
256 KB	7.68	6.98	6.87
512 KB	8.63	7.62	7.58
1024 KB	8.78	7.82	7.62

It can be seen from the data in the above table that the throughput of group A is close to 9 mb/s, while that of group B and group C is only less than 8 MB/s. Finally, the storage virtualization in the disk linear mode is transformed into the virtualization in the slice mode. In the test, two hard disks are mapped to the learner's client, and a logical disk is synthesized according to the slice mode, so that the host can read and write at the same time, that is, upload and download learning resources at the same time. The comparative test results are shown in Table 6.

Table 6. Comparison results of simultaneous read and write operations.

Shared block size (KB)	Experimental group A throughput (MB/s)	Experimental group B throughput (MB/s)	Experimental group C throughput (MB/s)
16 KB	1.73	1.59	1.46
32 KB	3.79	3.48	3.23
64 KB	4.89	4.64	4.51
128 KB	6.07	5.78	5.54
256 KB	7.48	6.68	6.51
512 KB	8.25	7.48	7.39
1024 KB	8.35	7.52	7.41

According to the data in the table above, the data throughput of the three groups of systems decreased when reading and writing operations were performed simultaneously, but the data throughput of group A was still larger than that of group B and group C.

3.2.2 The Second Set of Experimental Results

On the basis of the first group of experiments, fixed transmission of a learning resource packet, the resource packet arrival rate of the three systems is 100%, recording the sending time and receiving time, and conducting many experiments to obtain the delay time of system transmission information. The comparison results are shown in Table 7:

Table 7. Comparison results of delay time.

Number of experiments	Group A delay (s)	Group B delay (s)	Group C delay (s)
1	0.48	1.02	1.13
2	0.42	1.09	1.12
3	0.43	0.99	1.08
4	0.39	0.98	1.18
5	0.51	1.01	1.15
6	0.47	0.96	1.14
7	0.46	1.03	1.11
8	0.44	0.99	1.09
9	0.41	0.95	1.03
10	0.44	1.04	1.15

According to the data in the table above, the delay time of transmitting learning resources in group A is far less than that in group B and group C, with an average delay of 0.46 s. The average delay of group B and group C is 1.01 s and 1.12 s respectively, and the delay time of group A is reduced by 0.55 s and 0.66 s respectively. To sum up, in the process of transmitting learning resources, the design system improves the data throughput, reduces the data delay, and the resource transmission efficiency is higher than the traditional system.

4 Conclusion

The mobile learning system designed this time uses wireless communication technology to improve the transmission efficiency of learning resources. However, this research still has certain shortcomings. In future research, we will better grasp the development trend of mobile devices and wireless communication technology, and create a mobile learning environment that makes learners more satisfied from the needs and usability of learners.

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