DESIGN AND IMPLEMENTATION OF THE MOBILE LIBRARY APP BASED ON SMART PHONE

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Abstract:

Nowadays, the domestic mobile digital library services are facing the problems of high similarity, lacking innovation and inconvenience. In this paper we put forward and develop a mobile library application for smart phones. Based on the traditional library services, we take the users' personal preferences into consideration to provide better book recommendations and novel reading services, thus making the most of the resources of library and promoting the development of library's digitalization.

Keywords:

Mobile library; Seamless access; Load balancing; Personalized recommendation

1. Introduction

With the development of wireless network technology and the popularity of smart phones, mobile library service, marked by SMS and WAP service, has become a hot research topic .[1,2] Foreign countries such as Japan, Korea and United states start the development of the mobile libraries application earlier than China. Up to now, mobile library applications from Peking University, Tsinghua University, Wuhan University and HKU (University of Hong Kong) have been released to the domestic market.

When it comes to the content of mobile library service, both domestic and foreign mobile library services mainly provide resource query service. [3] Domestic mobile library services mainly focus on literature navigation, recommendation and readers feedback while foreign mobile library services lay more emphasis on providing novel service forms such as mobile reference consulting service, social network links and mobile study plan service. [4,5]

Seen from the form of the service, foreign mobile library services offer diverse service forms and give priority to the way of WAP website service while message service and client software are complementary.[6,7] The domestic mobile libraries mainly base their services on SMS and WAP websites, the service forms tend to be similar.[8,9]

At present, the domestic mobile library services are in the transitional phase from SMS to WAP services. But the WAP website domain name is not easy to memorize and its response speed is not high enough, so this kind of service cannot provide a very good user experience.[10] All in all, both the way of SMS and WAP domestic mobile library services are merely simple extension of the traditional library service, suffering from the problems of high similarity, lacking innovation and unsatisfying user experience. In today's information explosion, more user personalized services are needed. [11]

Based on the analysis above, we put forward and develop a mobile library application on smart phones. Based on the traditional library services, we explore some novel forms of reading service. The structure of this paper is as follows, the second part introduces the key technology of application development. The third part gives the details of the key techniques. The fourth part carries out a comprehensive evaluation of design of the APP and conclusion is described in section 5.

2. Key technology

The goal of designing the mobile library application is expanding the traditional library service. The application applies the techniques of book recommendation to fulfill the users' requirements.[12] During the development, the problems we have to solve are:

1) The seamless access of the original system

Seamless docking the existing systems and inheriting the current services are one of the most important requirements of our application. The existing web system has provided a complete traditional service; we can apply the API provided by those systems to carry out the secondary development. In the design of the application, due to the different structure of different systems API, we have to rely on the existing systems as little as possible while inheriting the services they

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provide completely. Lower dependence can help reduce the workload and shorten development cycles.

2) Load balancing based on high concurrent access and massive data flow

Traditional clients are generally deployed on the user's clients directly; since the requirement of throughput and concurrency is low, Simultaneous threading programs are able to handle the computation well. In large-scale application environment, however, the server-deployed application must apply proper strategy to deal with the massive visits and data flow because all the data flow between user terminal and system have to be forwarded by the server. With the development of the business and the rise of users' visits, the data flow grows rapidly. Considering that the data flow is mainly unidirectional, so we only need to optimize the data transmission between the source data terminal and the data forwarding center. The CDN(content delivery network) and cache techniques can be applied to help users obtain the nearest resource and reduce the load of the transmission, thus improving the availability and stability of the system.

3) Personalized recommendation based on user information

Personalized recommendation makes use of user's personal information such as interests, borrowing habits and search record to recommend library resources to users. [13] With the rising number and diversity of library collection resources, users need to spend a lot of time in searching for the books or other electronic resources they want. [14,15] In our system, the user's personal information and the comments of the literature are combined to generate the literature recommendation, which is also our research focus and a key point to provide smart mobile library service.

3. Specific implementation

3.1. Seamless access to the original system

To achieve the docking of original systems, there are mainly two ways, one is calling the API provided, the other is deploying a server which acts as the data mapping center between the library system server and clients. The strategy of using API is popular because it does not require extra servers, but it relies heavily on the original library system. Our application combines the merits of the both strategies to achieve seamless access. Using this strategy not only helps us reduce the developers' workload and the dependence on the original systems at the same time, but also make the application offer complete forms of services and good user experience.

Reading the basic data from the database directly will obviously bring risks to the performance and security of the system. We use open API based on XML and Web Service to achieve the interaction with the database. The application takes the URL hyperlinks as input and receives the output message in XML format. The interaction pattern is shown in figure 1.

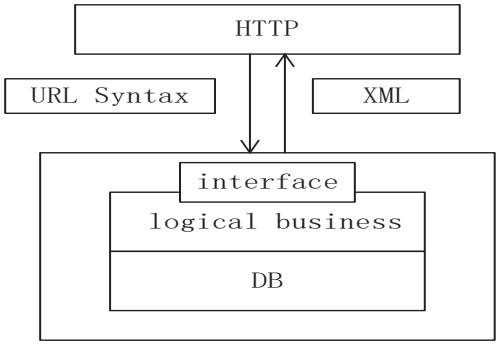

FIGURE 1. Call the public interface of access

Using the public API, the application is able to access the existing library systems regardless of the system structure, internal protocol and organization. The interface works when the server is running properly and focuses on the system's functional requests. The interfaces based on XML and OPAC server Web use same kind of request queue, and the interface includes multiple services. Each service has its own service name and performs specific functions.

For those systems without an interface, an intermediate layer is designed to perform the mapping from the client request to the operation that the system can process. We deploy extra servers called mobile server to connect the mobile clients and the library system servers, the mapping servers help translate the operations and deliver the data. The deployment of mobile server is shown in figure 2. The mobile server maintains a XML mapping table, mapping the user operations to the original Web systems' operations.

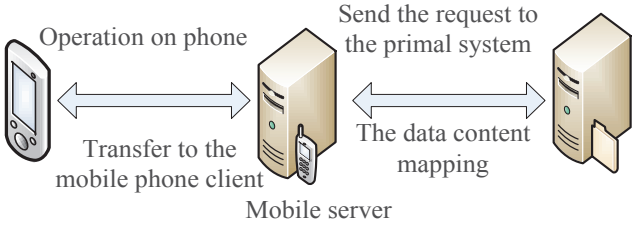

FIGURE 2. Deployment of mobile server access

By this mixing method, our application can complete all the system docking. The overall deployment mode is shown in figure 3.

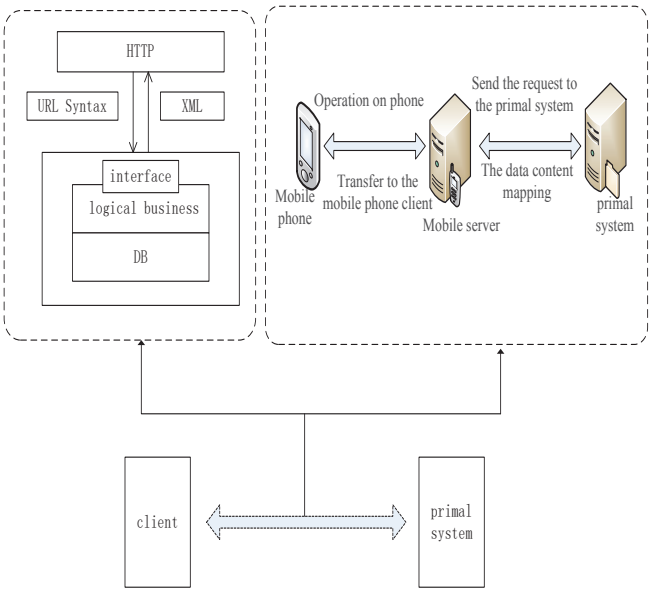

FIGURE 3. Hybrid access

3.2. Load balancing for handling high concurrent access and massive data flow

For the network transmission, cache technology enables the nearest access of the data, which is a very effective optimization of network data transmission. With the help of cache, transmission of redundant data can be reduced; many long distance transmissions can be changed to local network visits. In our application, the data transferred is mostly redundant, so using the cache server can greatly optimize the data transmission performance and avoid congestion.

Our application uses the CDN cache technology which is a new network caching technique. CDN places a Cache layer between the user and the server to guide the user's request to the Cache server. Each CDN node consists of two parts: load balancing device and high-speed cache. Load balancing device is responsible for adjusting the load of the device to ensure the work efficiency of the node. Cache servers are usually deployed on the edge of the network while the client cache is deployed on the exit of the network. The content is stored locally to improve response speed and save bandwidth. The server-side deployment of the cache works as the front-end of the server, which can improve the performance and accelerate the access speed.

CDN processes the users' requests and mainly delivers the static content to the edge nodes on the internet. With the help of CDN, users can get the requested content from the nearest server, which greatly reduces the system response time and chance of network congestion. Due to the limit of a single server's processing capacity, a CDN server may become the bottle neck of the whole system when the requests explode. To solve this problem, hardware load balancing devices are used; all the content servers are deployed to form a server cluster. The overall deployment pattern is shown in figure 4. The CDN is expected to handle more than 70% of the content requests, thus reducing the pressure of the server and improving the performance of the system.

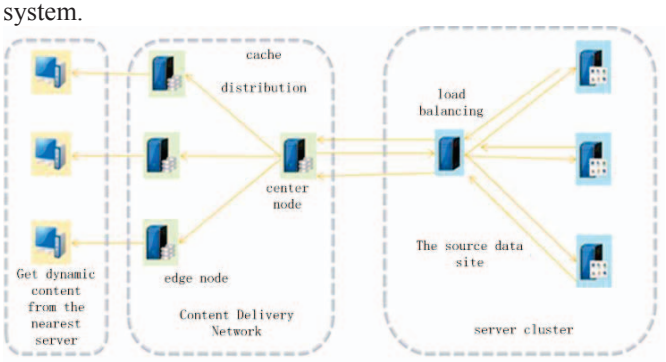

FIGURE 4. Load balancing using CDN

3.3. Recommendation based on users' personal information

User information includes user's specialty, age, gender, and borrowing history, through the study of users' personal information; we build a user model to represent a specific user. Book information includes ratings, comments, and category, from which we can build the feature model of a book. Then the user model and the book model are put into a recommendation algorithm to generate a recommended book list.

The book recommendation module consists of three parts: user model, book model, and recommendation algorithm. The flowchart of the recommendation process is shown in figure 5. The algorithm first searches for the books that match the users' interest, then apply some algorithms to further filter the generated list and push the recommended list to the user.

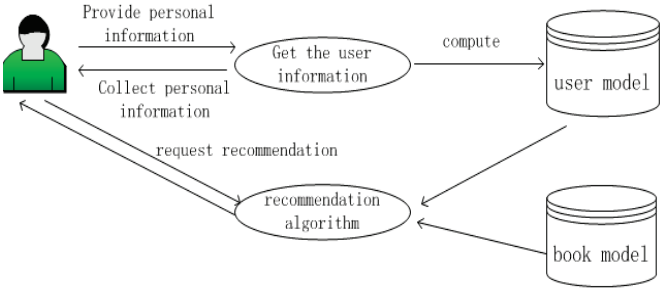

FIGURE 5. Book recommendation module

The recommendation system in this paper makes personalized recommendation to users based on user's basic information, habits, and borrowing history. It can not only provide users with personalized service, but also establish a close relationship between the user and application, which helps increase user loyalty.

4. Evaluation

In this paper we put forward and develop a mobile library application for the smart phone, the application not only provides the traditional library system's service, but also has the following characteristics: high resource loading speed, low network traffic consumption, high system response speed; high reliability on concurrent access; high adaptability; low dependence on original system, good flexibility; user-adaptive; novel forms of library service. The application in this paper outperforms the other domestic library applications in function, characteristics and main technical parameters; the comparison is shown in table 1.

TABLE 1. Main mobile library APP contrast table

	Our APP	*Tsinghua university library*	*Peking University library*	*Hong Kong university library*
System access	A mixture of public interface and deployment of mobile server access mode	public interface	public interface	public interface
Load balanci-ng	Content delivery network and multiple source data node	Upgraded network, heterogeneo-us cluster, local optimal request allocation algorithm	Upgraded hardware, heterogeneo-us clusters	Heterogeneo-us cluster
Resour-ces retrieva-l	Personalized model for results optimization	Traditional fuzzy keywords query model	Traditional fuzzy keywords query model	Traditional fuzzy keywords query model
Other feature-s	book reviews, book recommend ations, real-time online consultation	Traditional services, intelligent mobile service robot	The traditional service, barcode scanning	The traditional service, map navigation, seat reservation

5. Conclusions

In this paper we put forward and develop a mobile library application for the smart phone. We reduce the dependence of the existing systems while keeping their functions. Our application also achieves seamless docking to the systems with poor openness. The CDN is applied to perform the load balancing, which improve the response speed and reduce the pressure of the server. What's more, the recommendation system takes advantage of the users' information to provide personalized and accurate recommendation. The design and solution in this paper provides a good reference for the similar products.

Acknowledgements

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References

[1] Yue, Hong, Research and development of the mobile library based on WAP technology, 2010 2nd International Conference on Industrial Mechatronics and Automation, ICIMA 2010,191-194.

[2] AL-Faresi S, Patel N. The design of an adoption and acceptance framework for mobile digital library services[C]//Infuriation Society (i-Society), 2012 International Conference on. IEEE, 2012, 216-224.

[3] Liu, Chun-Jing, On information service of mobile library, 9th International Symposium on Linear Drives for Industry Applications, LDIA 2013. 2014:67-74.

[4] Lv, Yun-Hong, Research of mobile library information service, 3rd International Conference on Information Computing and Applications, ICICA 2012, 678-685.

[5] Chiu Po-Sheng, Pu Ying-Hung,Chen Tzung-Shi, Kuo Yen-Hung,Huang Yueh-Min, Design and development of a mobile library APP system, 3rd International Conference of Educational Innovation Through Technology, EITT 2014, 43-48.

[6] Sun Chang Li,Liu Chang,Shi Dan,Study on the architecture of mobile campus digital library system, 4th International Conference on Computer-Aided Design, Manufacturing, Modeling and Simulation, CDMMS2014, 425-429

[7] Meng XW, Wang F, Shi YC, Zhang YJ. Mobile user requirements acquisition techniques and their applications. Ruan Jian Xue Bao/Journal of Software,

2014, 25(3):439-456.

[8] Wang, Yingpei, Research on architecture of campus mobile library system based on cloud computing, 3rd International Conference on Green Communications and Networks, GCN 2013.2014:383-388.

[9] Zhao, Xiaoping, Architectural design of the university's management system of mobile library service, 2014 IEEE Workshop on Electronics, Computer and Applications, IWECA 2014, 340-343.

[10] Tang Kai,Zhang Yuan Yuan, Research on the construction of service mode in university mobile digital library, 2013 International Forum on Mechanical and Material Engineering, IFMME 2013, 1782-1785.

[11] Li Dan, Study on the mobile information service in the university library, 2013 International Conference on Mechatronics and Industrial Informatics, ICMII 2013, 2721-2724.

[12] Lingyun B,Xiaona F.Application of Web Service in Digital Library Information Retrieval System[C]2010 3rd International Conference on Information Management, Innovation Management and Industrial Engineering. 2010(3):289-292.

[13] Adomavicius G, Tuzhilin A. Context-Aware Recommender Systems. In: Ricci F, Rokach L, Shapira B, Kantor PB, eds. Recommender Systems Handbook. Springer-Verlag, 2011, 217-253.

[14] Ai DX, Zuo H, Yang J. Personalized mobile catering recommender system based on context ontology model and rule inference. Advanced Materials Research, 2013, 708-713.

[15] Fang W. On Personalized Service of Mobile Phone Library Based on Contextual Model [C]// Circuits, Communications and System (PACCS), 2011 Third Pacific-Asia Conference on. IEEE, 2011, 1-4.