INFORMATION
TECHNOLOGY JOURNAL

Research and Development of LBS-based Ethnic Cultural Information Resources Smart Recommendation System in Mobile Internet

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Abstract: There exist bottlenecks when spreading the ethnic cultural substantiality resources in traditional Internet. This problem and the issues like "small minority" recommendation in ethnic cultural information resources are first analyzed. Based on the Location Based Services (LBS) characteristics of mobile Internet and the geographical distribution characteristics of ethnic cultural information resources, we developed the "ethnic cultural information resources smart recommendation system" with the Android smartphone as the mobile terminal and gave the detailed implementation of key technologies. Through Global Positioning System (GPS) of mobile terminal and the Intelligent Information Push and Pull pattern, this system makes the smart recommendation available for the ethnic cultural information. And the problems like "user cold start" and "self-closing" are also solved. The system can improve the ethnic cultural information recommendation service.

Key words: Mobile internet, location based services, ethnic cultural information resources, smart recommendation android, user cold start, GPS

INTRODUCTION

Internet has a significant influence on all countries around the world and especially on the culture. The capability of effective spreading the ethnic culture of our country on the Internet and making the excellent ethnic culture getting better inheritance and promotion play an important role in public culture services. This is very important to the maintenance of ethnic cultural security and the enhancement of the cultural soft power and cultural influence. Currently, the common form of spreading ethnic cultural resources on the Internet is online virtual simulation museum corresponding to the physical resources such as the ethnic culture museums or exhibitions and their collections. There are several bottleneck problems existing in the virtual simulation museum on the traditional Internet. First, it is difficult for us to completely reproduce the sense of photorealistic and texture based on the existing digital technology. Second, the existing network transmission technology can hardly transmit large amounts of these high-dimensional virtual simulation resources reliably. That's why the numerous online virtual simulation museums fail to get wide acceptance and why the online virtual simulation museums can not replace the ethnic cultural physical resources that users can experience personally. As the product of mobile communication and Internet, the emerging mobile Internet is a research hotspot in the current information technology domain (Luo *et al.*, 2011). Its characteristic of LBS (Location Based Services) offer location-related information service by identifying the user's geographic location. The features of LBS like "position" and "dynamic interaction" are the critical features which distinguish the mobile Internet from the traditional Internet. And these features are the source of new applications produced in the mobile Internet (Liu *et al.*, 2011). Take China as an example, this study define the distinctive service information and other special ethnic cultural information associated with the ethnic culture as the ethnic cultural information resources. The distinctive service information is consistent with the geographic distribution characteristics and can accurately reflect the ethnic cultural substantiality resources and its spreading and promotion. So we developed an ethnic cultural information resources smart recommendation system and gave the detailed implementation of key technologies.

REQUIRMENTS ANALYSIS AND DESIGN FRAMEWORK

Requirements analysis: Because it is impossible for online virtual simulation museums to replace the users' real experience of ethnic cultural substantiality resources,

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we should change our way of providing information services. Based on the emerging mobile Internet, we proposed a new way. By providing mobile users with the ethnic cultural information resources recommendation services, this new way aims at stimulating the users to experience the ethnic cultural substantiality resources. These information resources are intelligently recommended to mobile users, thus providing information guidance for users and stimulating them to experience ethnic cultural substantiality resources personally. As we all know, the cultural characteristics differ from prefecture region to prefecture for all Chinese ethnic groups. Because Chinese prefer to live in one place for generations, the characteristics of geographical distribution and culture both remain steady. So, ethnic cultural information resources have something different from the ordinary. For a particular ethnic group, the ethnic cultural information resources are characterized by geographical-related distribution, while the ordinary information resources distribution are not obviously related to geography. Apparently, the geographic distribution characteristic of ethnic cultural information resources is more suitable for the LBS characteristic of mobile Internet. In addition, compared with ordinary information resources, ethnic cultural resources belongs to "small minority" resources. In the popular resource groups, the user often encounter greater difficulties in finding such rare "small minority" resources. Such information loss or information overwhelming occurs frequently. Currently, the mobile recommendation applications for popular information are mainly about life guidance, E-commerce, game and study (Liu *et al.*, 2011). In life guidance, the typical applications are Yowza and the "Public Comments". In E-commerce and game and study, the typical applications are GROUPON, MyTown, Voxy and 16Fun. However, these popular mobile Internet recommendation systems fail to solve such problems as information loss or informationoverwhelming perfectly. And we cannot directly apply these systems to the recommendation of the relatively rare ethnic cultural information resources. In practice, the recommended ethnic cultural information resources are lightweight and mainly in the forms of text and image, which can meet the need for efficient information flow and fast browsing with various hardware storage conditions of smart mobile terminals. In general, the information recommendation services application for the "small minority" ethnic cultural information resources is really in need and technically feasible. Our system can assist in completing the dynamic promotion of ethnic cultural museums and exhibition halls and their ethnic culture campaigns and can also help users to get information on the dynamic

ethnic culture in their areas. Few researchers have done related research of the LBS-based nonprofit information recommendation service application, especially for the dissemination and promotion of ethnic culture.

Design framework: Design framework involves smart recommendation, user cold start, self-closing of small minority and technology selection:

- Theoretically, LBS-based information services patterns are in theory classified into two categories-Pull and Push. Pull pattern means that the client initiates a request to pull information and Push pattern means that the server actively pushes information. The above two patterns are both inadequate. The most significant drawback of the pure Pull pattern is that the results of information services will be directly limited to pull request level of users. The most significant drawback of the pure Push pattern is as follows. Due to its poor ability to target, server cannot be accurately informed whether users are willing to receive the message and provide feedback after the universal information push. Especially in the mobile Internet, mobile users will be more likely to choose to close an application of Push service because of interest or the need of reducing power consumption of mobile terminal. From the perspective of practice and application, Push mode does not achieve the desired success in the mobile Internet independent of Pull mode except in such proprietary occasions as large-scale media and marketing. It is generally accepted that the mobile application system can not abuse the Push service. Otherwise, it will cause disgust of users, thus making the effect counterproductive. IIPP (Intelligent Information Push and Pull) pattern combines Pull pattern and Push pattern, which adds smart information push service in information pull service, thus improving capability of providing active information services of information systems (Peng, 2005). In practice of the mobile Internet services application, IIPP pattern which differs from pure pull or pure push pattern is usually called information recommendation and has been the popular pattern. In fact, the LBS-based IIPP in the mobile Internet is more technical feasible than that in traditional Internet and allows for more precise information recommendation service. The reason is that the IIPP in traditional Internet usually has no features related to geographical location. Therefore, IIPP in traditional Internet depends on using some data mining software algorithms to optimize the information

recommendation service. Due to the geographical location relating features, IIPP in mobile Internet can provide more clear, more direct and more accurate information recommendation services for users. Based on the geographical location relating characteristic of LBS in mobile Internet and ethnic cultural information resources, we made requests of users transparent, thus improving the validity and relevance of the ethnic cultural information resources recommendation. Here, so-called transparency means that the mobile client instead of the users sends pull requests to server or automatically offer candidates for the pull requests for users and what users need to do is to receive the results of such smart services without understanding how it is completed. In other words, the system shields users from the details of recommendation service implementation

- "User cold start" means that it is difficult for the system to understand preferences of the new user. This is an issue that all kinds of recommendation systems are concerned about (Meng and Ci, 2013). Cena *et al.* (2006) proposed solving the "User cold start" problem by the attributes of age, gender, occupation and so on. According to the characteristics of LBS and ethnic, our system can provide the minorities name indexes and targeted preference candidate elements for the new registered users and new comers of some regions
- "Small minority" may lead to "self-closing" and apparently open system is more conducive for the spreading of ethnic culture. In our system, an information pipeline which connects public social networking (Tencent Weibo in China herein) and itself is finished by programming
- Present system selects Android smartphone as mobile terminal. In fourth quarter of 2012, global market share of Android is 70.1%. Android application development uses Java, though programming language of Android underlying development is C. That's why Android applications are more open, fast and robust. In summary, we chose Android 4.0 SDK as the base, Eclipse as the integrated development environment and Java as the programming language.

SYSTEM DESIGN AND IMPLEMENTATION

Design of system functions: Present system consists of five core functional modules, including user location positioning, smart recommendation on ethnic cultural promotion activities and substantiality resources, user preference assistance setting, ethnic cultural knowledge

show and recommendations and disjunctions on external ethnic cultural information. Among these modules, "User Location Positioning" is technical support module and the rest are applications. Function of each module is as follows. "User Location Positioning" is designed to get the location of users and provide the information for other applications by analyzing the positioning data of GPS. "Smart Recommendation on Ethnic Cultural Promotion Activities and Substantiality Resources" is used to send location information of one user to the server transparently instead of the user. Then the server intelligently recommend the introduction of ethnic culture promotion activities and ethnic cultural substantiality resources in the region where the users are at. "User Preference Assistance Setting" module actively offers one user the name indexes of major ethnic minority groups in his or her usual residence and moving location and the user can choose some as collection. "Ethnic Cultural Knowledge Show" is for the active recommendation on the relevant ethnic cultural knowledge based on "User Preference Assistance Setting". According to the dynamic "User Preference Setting", "Recommendations and Disjunctions on External Ethnic Cultural Information" extracts therelatively scarce ethnic cultural information from Tencent Weibo and recommends it to the user. System function diagram is shown as Fig. 1.

Design of database: SQLite is chosen as the database for the mobile terminal. SQLite database is lightweight and has strong data processing capabilities supporting Java extensions. It is the typical representative embedded relational database (Allen and Owens 2010). The database of application server is MySQL. Main data tables include ethnic_info (ethnic cultural knowledge and information) table, favorite_list (user preference information) table, ethnic_region (geographic distribution information of the world) table, user_info (registration information of system user) table, user_role (user roles) table, event_list (ethnic culture promotion activities and substantiality resources information) table, event_interest_record (feedback collection of ethnic culture promotion activities and substantiality resources promotion) table, event_attend_record (participation records of ethnic culture promotion activities and substantiality resources promotion) table. Detailed database design is shown in Fig. 2.

Design and implementation of technical support module "user location positioning": GPS technology is adopted in positioning system of mobile terminals and invokes Android location services and google maps service as well. Following classes are designed in the development
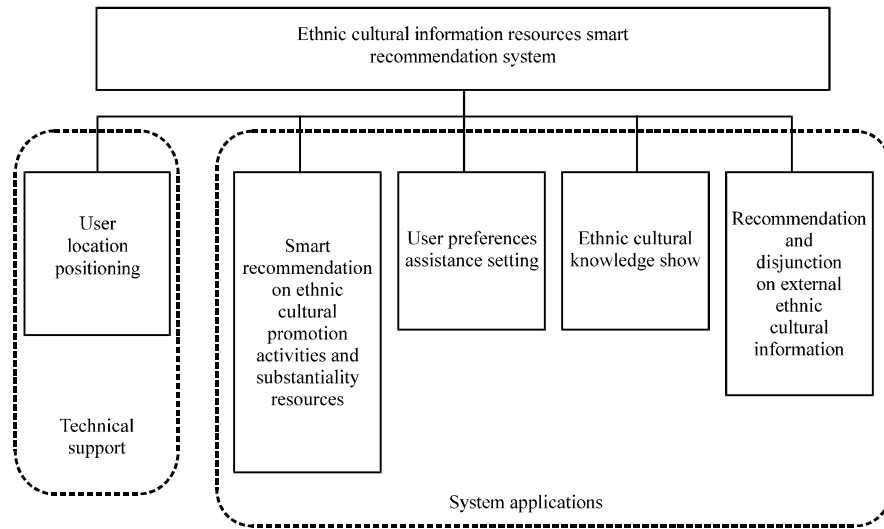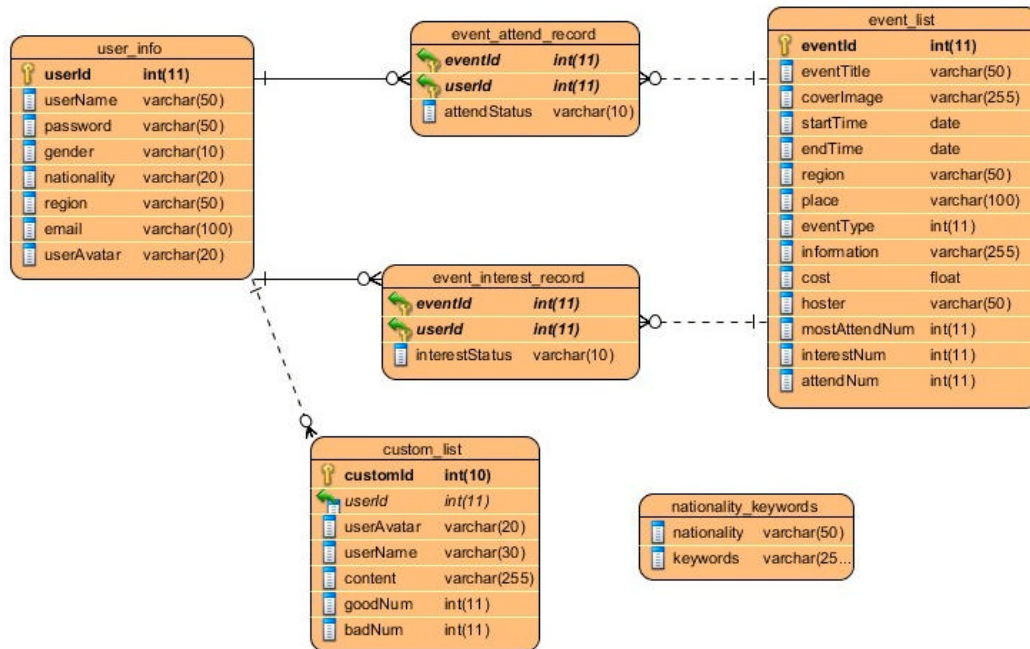
Fig. 1: Function diagram of our system

Fig. 2: Database designng

of "User Location Positioning" module such as
LocationManager class, LocationProvider class, Criteria
class, LocationListener class and Location class.
getBestProvider () method in LocationManager class is
called to get the location provider instance in the
development. Criteria class is used to determine the actual
specifications, standards or conditions of location
provider instance. LocationListener class is used to

monitor LocationManager until it returns non-empty GPS
data. getLatitude () method and getLongitude () method
in Location class are designed to get current latitude and
longitude of the user. Detailed development plan of "User
Location Positioning" is as following. (1) Based on the
Android location services of the mobile terminal, we get
current latitude and longitude of the user, in other words,
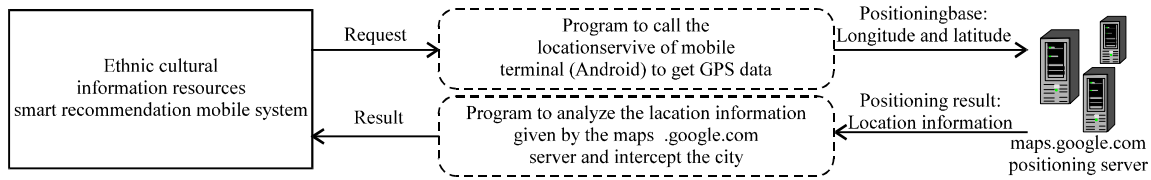the GPS data. (2) Latitude and longitude values are sent to

Fig. 3: Detailed technical implementation of "user location positioning"

maps.google.com server by programming and the maps.google.com server returns its geographical information according to latitude and longitude data. (3) Geographical information given by the maps.google.com server is analyzed to get current city of the user. Although GPS positioning accuracy is very high but we just get the current city of our users in the development. This choice is based on the following considerations. Compared to the macro total amount of information resources, ethnic cultural information resources are relatively scarce. If the chosen range is too small, the number even the probability of successfully getting ethnic cultural information service and resources promotion will reduce significantly after positioning. This will influence user experience. Fig. 3 shows the technical implementation scheme of "User Location Positioning".

Core codes of getting current location GPS data of the user is as follows:

```
String contextService=Context.LOCATION_SERVICE;
loctionManager=(LocationManager) getSystemService(contextService);
Criteria criteria = new Criteria();
......// some codes are omitted here.
String provider = loctionManager.getBestProvider(criteria, true);
loctionManager.requestLocationUpdates(provider, 2000, 0, locationListener);
double lat = 0.0;
double lng = 0.0;
private final Location Listener location Listener = new Location Listener()
{
    public void onLocation Changed(Location arg0) {
        if(location !=null){
            lat=location.get Latitude();
            lng=location.get Longitude();
            locationManager.remove Updates(this); }}}
```

Design and implementation of system applications: Design and Implementation of "Smart Recommendation on Ethnic Cultural Promotion Activities and Substantiality Resources" module. Details of ethnic cultural promotion activities and ethnic cultural substantiality resources are deployed in our application server by the authorized users of the system. When the ordinary users want to use this function, the system will automatically trigger the following events. The system informs the server of the current location information given by the "User Location

Positioning" module transparently. And the server will intelligently recommend the introduction list of all the ethnic cultural promotion activities and ethnic cultural substantiality resources in the city where the user lives. The communication between mobile terminal and server of the system is the key technology in this section. At present, there are three kinds of technical means of communication between mobile terminal and server in the system. These three kinds of technical means are Socket, Webservice and JSON. Although these technical means are widely adopted in software development, they still have different emphases with different features. Technical means based on Socket are very efficient and suitable for the development of the underlying functions. If applied in the development of high-level application-level, its cost is too much. Besides, permeability ofSocket means is not good enough in network applications. Webservice can transmit through the SOAP protocol with the form of XML. But data analysis of this technical mean is relatively complex and there are some compatibility issues. The third kind of technical means is the JSON format transmitting by HTTP protocol. Relatively speaking, JSON data analysis is simple and HTTP protocol is one good penetration in network applications. Based on these considerations, "JSON+HTTP" is chosen as the technical mean applying in the development of communication between mobile terminal and server. The detailed technical implementation scheme is as following. In the mobile terminal, HTTP protocol is adopted to send such parameters as current city information of the user (transparent to the user) in GET way successfully. And the corresponding Servlet is called in the server according to the mapping in the parameters information. EventDaoImpl class is designed on server. Using DAO mode, Servlet in the server get request parameters from mobile terminal and then calls the relating methods in EventDaoImpl class after receiving request parameters. Relevant methods in EventDaoImpl class is implemented in server to complete data queries of "Ethnic culture promotion activities and the substantiality resources in the city where users currently live". When the queries are completed, a result set is returned. All fields are
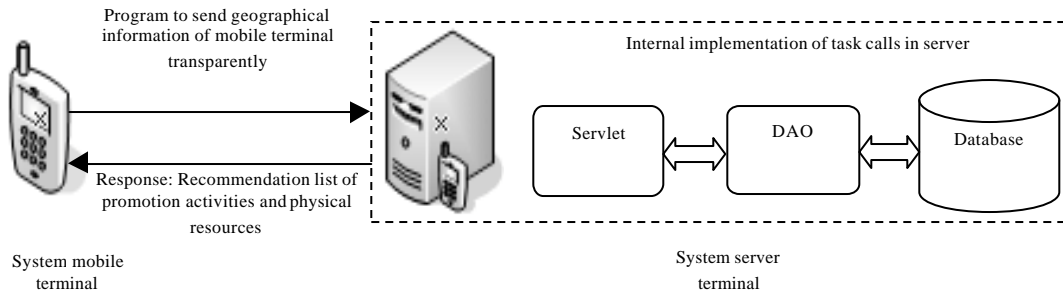
Fig. 4: Detailed technical implementation diagram of "Smart Recommendation on Ethnic Cultural Promotion Activities and Substantiality Resources" module

encapsulated into a JSON object and then added into JSONArray as an array element. After all array elements are saved, an integral JSON object is defined. Then, the JSON array is encapsulated in this integral JSON object to get the final JSON string. This string is written to Response through Servlet and is returned back to the mobile terminal. The received JSON string of the mobile terminal is analyzed to complete subsequent operations. In addition, our system predefines thread limit mode before mobile terminal connecting with server because development of this system is based on Android 4.0 and Google introduced StrictMode (limit mode) after Android version 2.3.

Figure 4 shows the detailed technical implementation diagram of "Smart Recommendation on Ethnic Cultural Promotion Activities and Substantiality Resources" module.

Here, we take the specific implementation of getEventInfoByRegion () method in the EventDaoImpl class designed in system server for example. According to the geographical position parameters from mobile terminal, the method queries the ethnic cultural promotion activities and substantiality resources information around present location of the user from the event_list table and

```
String sql = "select * from event_list where region like %?%";
    Connection conn = null;
    PreparedStatement pstmt = null;
    ResultSet rs = null;
    conn = DBUtil.getConnForMySql();
    pstmt  =  DBUtil.getPreparedStatemnt(conn,  sql,new  String[]
{province});
    rs = pstmt.executeQuery();
Core codes of encapsulating the query results into a JSON string is as
following.
  while (rs.next()) {
      JSONObject eventInfo = new JSONObject();
      eventInfo.put("eventide", rs.getInt("eventide"));
      ......// some codes are omitted here
      // Encapsulated into a JSONArray array
  eventArray.add(eventInfo);
      }
```

encapsulates the query results into a JSON string. Core codes of database query operation in the method of GetEventInfoByRegion () are as following:

"User Preferences Assistance Setting" is intended to improve the problem of "User Cold Start". This system requires the new users to provide their ethnic characteristics and usual residence. Then the system provides the name indexes of major ethnic minority groups which are in the usual residence and the places the users move to and the ethnic characteristics of the new users with a friendly reminder, allowing users to decide whether to put it into personalized collection. In addition, users can manually add or remove ethnic name indexes.

Design and implementation of "Recommendations and Disjunctions on External Ethnic Cultural Information" module. Our main purpose of the "Recommendations and Disjunctions on External Ethnic Cultural Information" module is to make the system far from "self-closing" and access to public social network chain, which means making the system of certain openness. The corresponding technology fact is that the typical social network and its UGC (User Generated Content) have developed into big data platform. The UGC have already grown from the original simple data object into important basic data resources with characteristics of 4V including volume, variety, velocity and value (Meng *et al.*, 2013). In China, Weibo has become typical representative of big data platform currently. Take Tencent Weibo for example, the number of Tencent Weibo registered accounts has reached 540 million and the number of average daily active users exceeds 100 million up to the end of 2012. The UGC it holds has developed into important basic information resources from the original simple Weibo data. Present system chooses Chinese Tencent Weibo big data platform as the representative information sources of disjunction and recommendation on external ethnic cultural information. We have applied for AppKey and
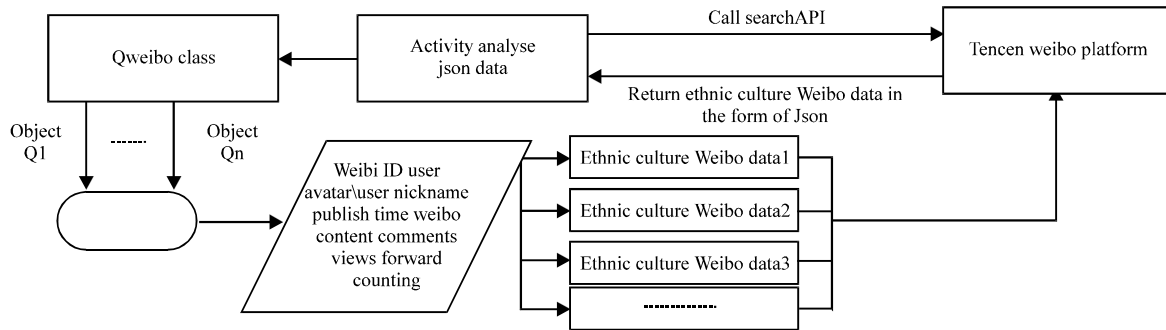
Fig. 5: Specific technical implementation scheme of disjunction of ethnic cultural information from "Tencent Weibo" platform

AppSecret of the Weibo. Our system allows users to login through Tencent Weibo accounts, get information related to ethnic culture from Tencent Weibo by the way of Oauth certification serviceauthorization. And at the same time, present system can forward new ethnic culture information to "Tencent Weibo" in the form of comments and other ways. The specific technical implementation scheme we adopted is as following. Taking the relevant ethnic groups name indexes which update with the location change of mobile terminal in "User Preferences Setting" as delivery parameters, the system calls the SearchAPI in Tencent Weibo. Tencent Weibo server returns a JSON object including JsonArray. Each array element is a piece of detailed introduction of ethnic culture Weibo associated with ethnic characteristics. Parse the content of each array, design and implement an entity class QWeibo, store the parsed content into QWeibo object and then put all Qweibo objects into ArrayList <Qweibo>. The control used to display the ethnic culture weibo of mobile terminal is ListView. By setting Base Adapter for it, the system determines the Weibo content displayed in the system mobile terminal. For the non-text part (such as pictures) of ethnic culture Weibo, we use asynchronous loading method based on memory and multi-thread in development to speed up the ethnic culture Weibo loading in mobile terminal.

The specific implementation of mentioned technology is shown in Fig. 5. Based on the module, users can select read ethnic culture Weibo, comment on and forward them. Thus, it is clear that this system is no longer "self-closing" and has become an open node in social network. And the "open" node has both national culture information inflow and outflow.

We overwrite the getView () method of Base Adapter class and core codes are as following.

```
public View getView(int position, View convertView, ViewGroup parent)
{
    asyncImageLoader = new AsyncImageLoader();
        convertView = LayoutInflater.from(getApplicationContext()).inflate(
        R.layout.qweibo_item, null);
        // QweiboHoler is a class holding Tencent Weibo page control
elements.
        // Declare an object and initialize it.
        QWeiboHolder wh = new QWeiboHolder();
        wh.userAvatar    =    (ImageView)    convertView.findViewById
(R.id.weibo_head);
        wh.userNick    =    (TextView)    convertView.findViewById
(R.id.weibo_nick);
        ......// some codes are omitted here
// Assign the elements content to the corresponding weibo control.
return convertView;}
```

RUNNING RESULTS

The server is deployed on the Tomcat server and mobile terminal is the smart phone with Android 4.0 or above. The end-users need to install apk applications in Android smartphone and deploy the mobile terminal on the smartphone. In order to ensure the effectiveness and the successful promotion, our software runs on the real machines of various models such as samsung GT-S7572 and SONY Ericsson LT18i instead of simulator.

Running results of "Smart Recommendation on Ethnic Cultural Promotion Activities and Substantiality Resources" module is shown in Fig. 6a-b. When the user move to Dalian, Liaoning China, the system intelligently recommended "Ethnic Minority History and Culture Exhibition Hall in Northeast China" and "China's Manchu Culture Lectures" and some other substantiality resources of ethnic culture and ethnic culture promotion activities to the user. Moreover, the system server can collect the user options of system mobile terminal such as "interest" and "I want to participate" to facilitate the organizer to know and evaluate the promotion effect of Ethnic Culture promotion activities and substantiality resources.

Running results of "Assisted User Preferences Setting". As shown in Fig. 7a-b, when the user is in
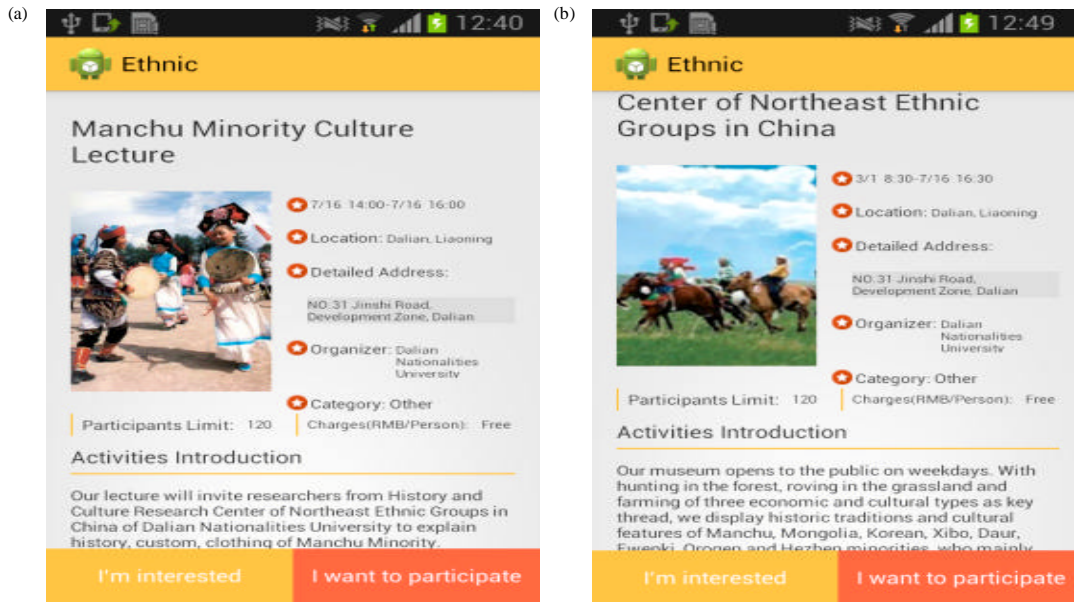
Fig. 6(a-b): User interface of "smart recommendation on ethnic cultural promotion activities and substantiality resources"
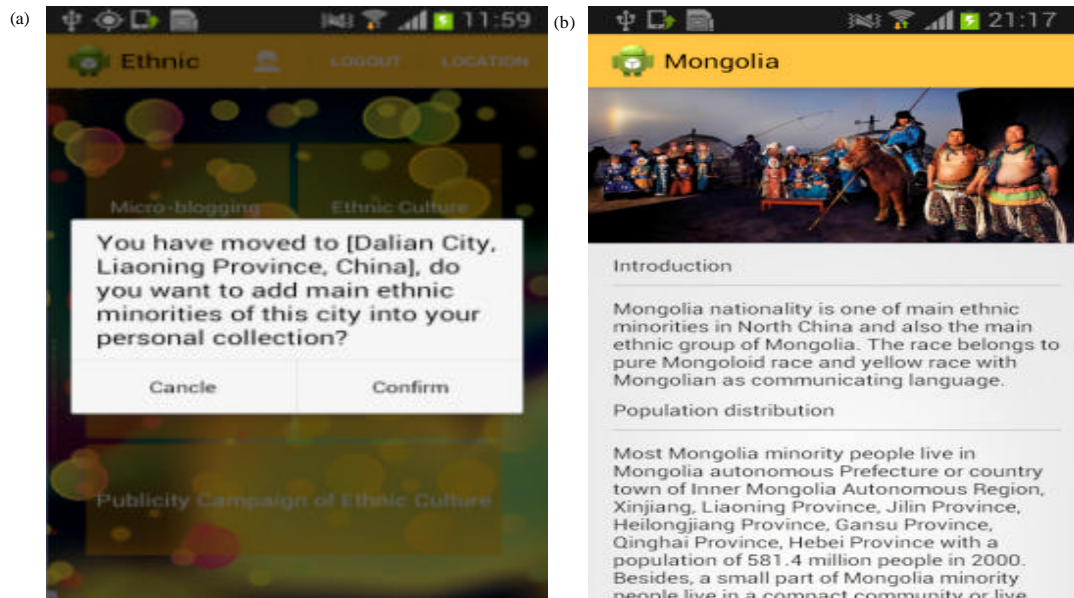

Fig. 7: User interface of "User Preferences Assistance Setting" module and ethnic cultural knowledge

Dalian, Liaoning, the system will initiatively provide the name indexes of major ethnic minorities for user and give prompt. The result is shown in Fig. 7a. If the user chooses "Confirm", the major ethnic minorities in Dalian will be put into the personalized collection automatically. Users can also enter an ethnic cultural knowledge related display interface. Results are shown in Fig. 7b.

CONCLUSION

The mobile application described in this study is a LBS-based Ethnic Cultural Information Resources Smart Recommendation System in Mobile Internet. It realized the intelligent recommendation on ethnic cultural information resources, improving the problem of "user cold start". As a "small minority" system, it avoids being self-closing. To some extent, it achieved the external ethnic culture information extraction and recommendation. And our software can solve problems such as information loss or information overwhelming and dynamic promotion of various ethnic cultural resources.

ACKNOWLEDGMENT

REFERENCES

Allen, G. and M. Owens, 2010. The Definitive Guide to SQLite. 2nd Edition., Apress, New York, Pages: 366.

Cena, F., L. Console, C. Gena, A. Goy, G. Levi, S. Modeo, I. Torre, 2006. Integrating heterogeneous adaptation techniques to build a flexible and usable mobile tourist guide. AI Commun., 19: 369-384.

Liu, J.N., C. Guo and R.Q. Peng, 2011. Location-based services in mobile internet era. Communications of the CCF, 7: 40-50.

Luo, J.Z., W.J. Wu and M. Yang, 2011. Mobile Internet: terminal Devices, networks and services. J. comput., 34: 2029-205.

Meng, X.F. and X. Ci, 2013. Big data management: Concepts, techniques and challenges. J. Comput. Res. Devel., 50: 146-169.

Meng, X.W., X. Hu and L.C. Wang, 2013. Mobile recommender systems and their applications. J. Software, 24: 91-108.

Peng, Z.H., 2005. An initiative information service of digital library from an angle of intellectual information pushing-pulling technology: Measure studies. Inf. Document. Services, 62: 84-86.