

Design and Implementation of an XML-based Universal Mobile Data Acquisition System

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Abstract— This paper introduces a universal mobile data acquisition system. The innovation of this system is that it can be used for different applications. By simple customization, it can meet the needs of different users, without developers' design and development work time after time. To take the data acquisition work about plants and animals in Qinghai Lake Nature Reserve for an example, this paper shows the design and implementation of this universal mobile data acquisition system.

I. INTRODUCTION

Advances of mobile data acquisition system based on Personal Digital Assistant are making data acquisition faster, easier, and more accurate than paper-based data collection methods^[1]. At present, mobile data collection systems have been widely applied in many fields: medicine^[2], transportation^[3], agriculture^[4], geography^[5], and so on. But since they are specially designed and developed for a certain application independently, which have disadvantages of long development period and poor expansibility. At the same time, we saw wide and pressing demand of mobile data acquisition systems in many institutes of Chinese Academy of Sciences and Nature Reserves. They need mobile data acquisition systems to change their traditional way of paper-based data collection.

Based on the things in common of different data acquisition systems, we design a universal mobile data acquisition system. Through simple customization, it can meet the demands of different users. So this system not only avoids developers' repeated development work, but also reduces the complexity of the maintenance. If the demand changes, a user only needs to change the configuration, without any development again.

II. ARCHITECTURAL STRUCTURE AND FUNCTION

The key problem of realizing the universal system lies in how to provide a simple, universal way of customization, how to save customized information, and how to generate correct data acquisition forms on PDA as users want.

Considering that data acquisition applications generally need corresponding relational databases for data application, and by extracting table structure metadata of the database, the system can automatically get part of customized information, so we based on relational databases to provide users with simple customization mode, and take each table for data acquisition unit (one table in database corresponds to one data acquisition form on the PDA).

The universal mobile data acquisition system consists of three modules: customization module, data acquisition module, data synchronization module (figure 1). The steps of using this system is as follows: Firstly, users specify requirements of data acquisition based on the well-built relational database. The customization module will save the customized information to an XML file. Then use the data synchronization module to get dictionary data from the database, and copy the XML file and dictionary data to PDA. Finally, users start the program on the PDA and input data which will be exported to background database through the data synchronization module.

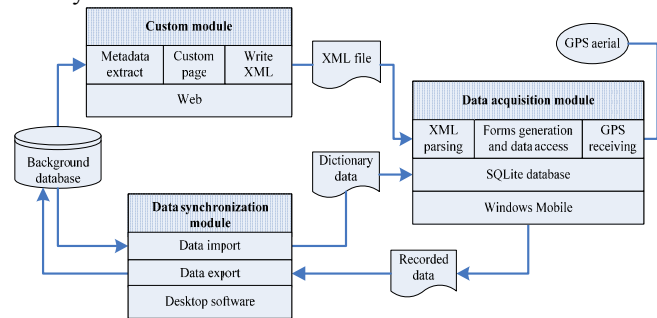


Figure 1 System structure

In the first step, users configure the connection parameters to background database (applicable to Oracle, SQL server, MYSQL database, etc). Then the customization module connects with the database and extracts metadata. Based on these metadata, users specify the title, primary key of each table and for each field, give the name, select the type and edit style, and set the default value, etc. At last, the system will store all these information in an XML file.

The data acquisition module is the program running in PDA. It consists of three sub-modules: XML parsing module, data acquisition forms generation and data access module, and GPS receiving module. XML parsing module analyses the XML file, and supplies information for data acquisition forms generation and data access module which dynamically adds input controls for each acquisition fields. If there is data of GPS type, GPS receiving module will automatically access and save such kind of data.

Data synchronization module consists of two sub-modules: data import module and data export module. It is desktop software. It builds up a bridge between the PDA, background database and the customization module. Because each

application system may have some static data(dictionary data), such as the plants' and animals' names in the Qinghai Lake Nature Reserve Database, so the data import module can extract these static data from some tables specified by users in the background database and import to the PDA. Data export module is used to upload the data recorded by users on the PDA to the background database. Before uploading, users can browse and edit the data to ensure the accuracy of the data.

III. DESIGN OF XML SCHEMA

The design of XML schema is the key problem of this system. The structure of XML file is as figure 2. The root element is <dataset> which contains <repository>, <table>, <relation>, <view> four kinds of child element. <repository> is one and only, while the others are repetitive elements.

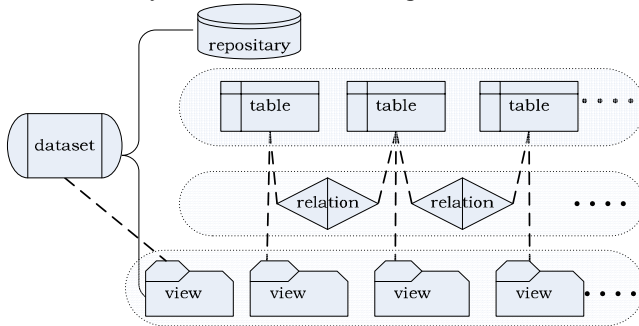


Figure 2 Structure of XML schemas

Information about database is stored in <repository> element. <relation> element stores the relationship between the two tables or three tables which indicate the foreign keys. <view> element is used to tell the system how fields and tables be showed on the PDA. Every table has a corresponding <view>, and the view contains the fields need be showed on the PDA (the primary key not showed generally). There is a <view> corresponding to the dataset which records the tables that will be showed as menu items.

IV. SYSTEM DEVELOPMENT AND IMPLEMENTATION

We implement the customization module as a web application with Java language. Because we choose Windows Mobile as our PDA experimental platform, the other two modules including data acquisition module on PDA and desktop data synchronization module are developed with c#. The development environment includes Visual Studio 2005, Windows Mobile SDK, SQLite3 and ActiveSync and 4.5.

To take birds investigation around Qinghai Lake for example, investigators travel around the lake, stop at some sites, and record many information for each birds. So we design three relational tables: Circle Lake Survey (A), Places Survey (B), and Birds Survey (C). The relation of table A-B is 1: n, B-C also is 1: n. The figure 3 shows the data acquisition interface of these three tables on the Windows Mobile 6.0 simulator. The three tables have relations with each other, so they are showed together with tab page. In figure 3, the field "Place name" is a foreign key point to the dictionary table "Places". So the system creates a combo box for the field and lists all the value in the "Place" table. Users only need to

select the correct value rather than type the value in the text box. The field "Weather" is an enumerated type whose values are set in the custom step. So users only need to select from combo box.



Figure 3 Data acquisition interface

V. CONCLUSIONS

XML-based universal mobile data acquisition system provides an automatic mode for outdoor data acquisition workers to record data and import data into background database. It is more convenient and effective than paper-based data collection methods. Furthermore, through simple customization, this system can be applied to many different applications, not only reducing the workload of developers, but also making the system easily expanded. Next, we plan to design cross-platform mobile data acquisition system, and diversification of data collection, including images, video, temperature data, etc.

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