Design of Android Warehouse Management Software based on Web Service

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Abstract. In the light of existing problems of computer-side warehouse management system, this paper puts forward developing an Android software and introduces smart phones to warehousing management. System adopts C/S three-layer architecture including the database layer, the service layer and the user layer. The service layer uses Web Service technology to provide data exchange service for Android software and the database. As the supplement of computer-side warehouse management system, the android software has most functions of computer-side warehouse management system. It ensures workers conduct warehousing operations anywhere in the warehouse, increases the mobility of warehousing management and improves service level and efficiency of enterprise.

1. Introduction
In recent years, functions of warehouse have become more diversified and complicated, the traditional manual management has been unable to meet the need of warehousing operations, which encourages the birth of Warehouse Management System (WMS) [1]. It is a kind of information management system based on personal computer (PC), which can effectively organize and manage warehousing operations and staff through network technology and database technology. It has advantages of convenient information query, large storage capacity, strong data processing ability, high reliability as well as low cost. However, warehouse management systems of most enterprises in our country are based on PC, which are fixed terminals, leading to low mobility, accuracy and efficiency [2].

And recently, smart phones represented by Android and IOS phones develop rapidly. In this paper, taking an automated warehouse of a university as research background, the idea of introducing mobile office into warehouse management and designing a warehouse management software based on smart phone is proposed. As a supplement of WMS used on PC, the application allows warehouse staff to achieve warehousing management and information query through mobile terminals anywhere in the warehouse instead of using fixed PC. After the storage and retrieval information of commodity is collected through the application (app), these data will be submitted to the server-side database.

Our primary contribution in the field of warehouse management is designing and developing a warehouse management software used on mobile phones. Compared to WMS on other platforms such as computer or Personal Digital Assistant (PDA), it is more intelligent and convenient, and the system is easy to achieve with low investment. This paper focuses on system architecture design, function modules design, and its achieving technology. Because of the server-side database and the Android application are on heterogeneous platforms, this paper proposes a C/S three-tier architecture based on Web Service technology to solve the communication problem between them. Function modules of Android-side software is developed from WMS on PC. And the system adopts Simple Object Access Protocol (SOAP)
and Extensible Markup Language (XML) for communication, which make data change more efficient and secure.

2. Key Technology

2.1. Android Platform
Created and developed by Google and Open Handset Alliance, Android operating system is a Linux-based, free and open-source operating system, mainly used in intelligent mobile phones and tablet computers [3]. The Android platform allows any organization and individual to join the Android alliance, which brings a lot of applications for users. Compared to the IOS system, Android phones have lower price and number of users in China, so Android system is more suitable for industrial working environment. This essay chooses Android as the platform to design intelligent warehouse management system. In addition, the Android platform has a wide range of libraries to meet developer's various functional requirements, among which the third-party library called Ksoap2-Android can help Android software visit Internet.

2.2. Web Service
Web Service is a platform-independent, low-coupled, self-contained application based on programmable web. It is identified by the Uniform Resource Identifier (URI), and its interfaces and bindings can be defined, described and discovered through XML artifacts [4]. Web Service supports software systems to communicate with each other using XML-based messages through Internet-based protocols.

Web Service can solve data communication problem between heterogeneous platforms. Software on PC terminals and mobile terminals can achieve information communication without additional, specific software or hardware. Web services are widely available in android applications, they can perform simple requests or any complex information processing. Once the service is deployed on IIS server, it can be invoked through the Web [5].

When the app wants to access the database, Web Service is a good choice. Create a web application project, then integrate operations of database including information query, adding data, updating data into a Web Service and deploy it to the IIS server. IIS (Internet Information Services) is a kind of basic Internet service provided by Microsoft running on Microsoft Windows. Web page can be published through IIS, and there is Active Server Page (ASP) generated at the same time. After the service is released, the service interfaces can be invoked through the specific URI to realize the dynamic access and operation of the database. Communication model of Android-side WMS is shown in Fig. 1.

![System Communication Model](image-url)
3. System Structure
This paper takes an automatic warehouse of a university as research background to design system structure. There is a set of monitoring and management system in the warehouse. It can give instructions to equipment through the Programmable Logic Controller (PLC) to move commodities and conduct warehousing operations. To increase the intelligence and mobility of warehousing management, Android-side WMS is considered. Because of communication problems between Android and PC terminals, this system adopts C/S three-tier structure including the database layer, the service layer, and the user layer. The service layer provides data communication service for the database layer and the user layer. The following specific description of three layers are given:

- The user layer: Android-side WMS is the user layer that provides warehouse staff operation interfaces. Users can input operating instructions about database through the user layer, receive response messages from the Web Service, decode and display them on the phones. The App provides functions such as storage and retrieval management, inventory management, commodity movement and information query.

- The service layer: The service layer uses Web Service technology to provide communication service for Android application and database. Web Service adopts ActiveX Data Objects (ADO.NET) technology to visit the database, achieving functions such as information query, adding data, updating data. These functions will be packaged into Web Service, which can be invoked by Android-side WMS once the Web Service is deployed on the IIS server.

- The database layer: The database layer is at the bottom of the system. It provides data support for WMS on PC and Android terminals. The database in the paper is SQL Server database, namely relational database.

The system architecture is shown in Fig. 2. In addition to the above layers, the monitoring layer is also displayed. The monitoring layer is the monitoring computer, which can directly scan data tables in the database, and issue instructions to the PLC.

![Figure 2. System Structure.](image-url)
4. System implementation

4.1. Realization of the database layer
The system uses Power Designer15 software to complete the construction of physical database model, and chooses SQL Server 2008 R2 as management software. The database layer provides data support for warehouse management software on PC and Android terminals. According to the actual need of the warehouse, the database has supplier table, administrator information table, commodity information table, customer information table, task table, task priority table, task status table, system log table.

4.2. Realization of the service layer
Under Microsoft Visual Studio. NET environment, Visual Studio 2012 helps the development of Web Service. ADO.NET component library employed in developing process is a database access technology created by Microsoft, which can visit the SQL database and XML data source. The system uses C# language to create interfaces of Web Service, different interfaces achieve different operations of the database. There is information query interface, logging authentication interface, storage and retrieval interfaces, and storage management interface in the service layer. Specific information is shown in Tab I.

| Interface Name | Interface Function |
|----------------|-------------------|
| GetData1       | Commodity information query |
| GetData2       | Supplier information query |
| GetData3       | User information query |
| GetData4       | Require information of location that has commodities |
| GetData5       | Require information of location that doesn’t have commodities |
| GetInOut       | Require inventory information |
| InsertTask1    | Add a piece of storage task |
| InsertTask2    | Add a piece of retrieval task |
| InsertTask3    | Add a piece of commodity movement task |
| selectADpwd    | Login verification |

Codes of defining and designing Web Service interfaces are placed in the WebServic1.asmx file, and once Web Service is deployed on the IIS server, these interfaces can be invoked by app through the network. Here take supplier information query interface as an example, and give the programming method:

```csharp
[Web Method (Description = "inquire supplier information")]
Public string GetData2 () {
    //invoke database operating function
    DataSet ds = dB Operation.GetDataList ("select * from T_Suppliers");
    Return DataTableJson (ds. Tables [0]);
}
```

After the service interface is defined, the next step is to design database operation functions. They are used by the service interface. Different interfaces require different operation functions. All functions are stored in the DBOperation.cs file. Web Service has operation functions such as adding data, updating data, data query, login verification, and getting order numbers. Here take adding data as an example, give the method of accessing the database. Adding data means adding a new record to the data table of the database, and it is often used by storage and retrieval interfaces. Warehouse staff input information through the user interface of warehouse management software on Android, the App invokes the Web Service interface, and then the information is sent to the Web Service function in the form of parameters.
The function receives parameters and add them to the database. Following is the programming method to design an operation function:

```csharp
// Instantiate a function
public bool inserttask(string F_OrderIndex, parameter2...){};

// write SQL statement
string sql = "insert into T_Manager_Task_Log(F_OrderIndex, parameter...)values (?,?...)",;

// connect with the database
SqlCommand cmd = new SqlCommand(sql, sqlCon);
cmd.ExecuteNonQuery();
cmd.Dispose();
```

4.3. Realization of the user layer

The user layer is the warehouse management software on android. The development platform is Eclipse and the development language is Java. The App can run on Android phones whose system version is 5.0.2 or lower.

4.3.1. Software Function Module. The user layer has five functional modules, including information query, storage management, retrieval management, commodity movement and inventory management. And the software has five function interfaces, through which warehouse staff can enter different functional modules.

![System Function module](image)

**Figure 3.** System Function module.

Information query module includes supplier information, commodity information and administrator information. Warehouse staff can get the basic information in the database through this function module.

Storage management and retrieval management refer to storage and retrieval operations of commodity operations through the android-side application. Take storage for example, warehouse staff use the App to input storage information, and the real-time data is submitted to the database task table. As soon as the monitoring system scans the latest record in the task table, storage task begins.

Commodity movement refers to changing the location of commodities. And inventory management refers to managing quantity and quality of commodities in the warehouse, including inventory information query and updating inventory information.
4.3.2. **Method of invoking Web service interface.** Warehouse staff enter different functional interfaces and input operation information before the mobile terminal passes parameters to Web Service. Then Web Service invokes the corresponding operation function and visit the database. Finally, feedback information is decoded and displayed on android.

The following case takes invoking log verification function as example, providing programming method of invoking Web Service and passing parameters between database and software on Android. Following is the programming method:

```java
//Specify the namespace of the Web Service and the method name
SoapObject soapObject = new SoapObject("http://tempuri.org/", "selectADPwd");
//Set parameters and assign contents of the edit box to the parameter.
soapObject.addProperty("F_User", editText1.getText().toString());
//Generate SOAP information that invokes web method
SoapSerializationEnvelope envelope = new SoapSerializationEnvelope(SoapEnvelope.VER11);
//Create HttpTransportSE transfer object, URL of the Web Service is in bracket.
HttpTransportSE httpTransport = new HttpTransportSE("http://tempuri.org/selectADPwd");
//Invoke log verification function of Web Service
httpTransport.call("http://tempuri.org/selectADPwd", envelope);
//Receive return value of Web Service
SoapObject object = (SoapObject) envelope.bodyIn;
//Assign return value to variable string, and return string
String one = object.getProperty(0).toString();
return one
```

4.4. **System analysis**

The content of this paper is the warehouse management software system based on Android platform, used for automated warehouse management and basic information query. Software can run on the Android smartphones and tablets, in which users open the software login screen to input the user name and password, then enter the main interface of the software after verification. In the main interface, the function can be selected.

Three-layer architecture of the system can be achieved by professional software in this industry. As for hardware configuration needed, the system is equipped with one computer in which database will be installed and the Web Service will be released. APP runs in Android intelligent terminal equipment. According to the whole system realization method, the system has economic feasibility and the system does not need to spend too much money. The Android storage management software could enhance the mobility and real-time storage management ability. And without the need of increasing the number of installed PC warehouse management system in the warehouse the efficiency of warehouse management improves. According to the above analysis, this paper has economic feasibility.

5. **Conclusion**

This paper focuses on the warehouse management in the warehouse, and proposes to develop a warehousing management software based on Android platform. The purpose of this system is to increase the efficiency and mobility of warehouse management, and make warehouse staff carry out warehousing operations anywhere in the warehouse. The system has following characteristics: based on the warehouse
management system on PC, developing warehouse management software used on Android, compared to those WMS used on Personal Digital Assistant (PDA) and PC, Android phone is a new platform; adopting C/S three-tier system architecture based on Web Service technology to solve communication problems between PC and Android terminals. WMS on PC and Android are both warehousing management tools. PC-side software can handle large amount of data and product reports, and Android-side software can conduct storage and retrieval, information query operations. The future research direction includes: 1) further improve functions of the software, adding functions like inventory alarm, RFID identification; 2) beautify the user interface and provide users more interactive service.

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