# Design and Implementation of Lujiazui Land Management Information System Based on WebGIS

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***Abstract*—The number of internet-based Geographical Information Systems (Web GIS) applications has rapidly increased in recent years, in particular with the emergence of sites such as those underpinned by Google Maps technology. Web GIS is seen as a useful tool for E-Government. The Land Management Information System based on WebGIS achieves the purpose of geographic data transmission on internet, and can improve the land information management level. It allows more people to enjoy the service of Geographic Information Sharing. From the status quo and developing needs of land in Lujiazui district of Shanghai, this paper puts forward the significance of building Lujiazui land system. In the paper, user needs, framework and functions have been analyzed emphatically. It is proved that the WebGIS system structure discussed in this paper is practicable.**

***Keywords-Land Management; Management Information System; Internet; WebGIS; AJAX; Geographic Information Sharing; E-Government***

## I. INTRODUCTION

With the rapid development of Internet, the network has become an important way for information dissemination [1, 2]. WebGIS is the product of internet technology used in GIS. It has been recognized increasingly that future developments in Geographic Information System (GIS) will center on WebGIS, geospatial data accessing and geospatial analysis [3]. WebGIS provides end-users a cost-saving solution to access up-to-date spatial datasets and information [4]. A WebGIS system is designed with tools and features that are common on Web pages and therefore it is easy to understand for users who are familiar with the internet [6]. People can browse the WebGIS site to get geographic information from any other node on internet, and conduct a variety of information retrieval and processing. WebGIS provides the practical technology for the geographic information sharing. People could get the desired information with intuitive browser queries.

Shanghai is a big city with small rural areas. Its land area is only 0.07% of China. With the development and opening up of Pudong, more land is needed to fit the urban construction. The contradiction between supply and demand of land resources is becoming increasingly prominent in Shanghai where land has been heavily used. Lujiazui Functional Area is located in the northwest of Pudong New Zone. The scope of the study is the whole Lujiazui Functional Area and five parts are included, which are Meiyuan Street, Weifang Street, Tangqiao Street, Yangjing Street and a part of Huamu town. Lujiazui Functional Area is the focus of planning and construction of Pudong, and is also one of the most important zones of Shanghai. It plays an important role for the international city image-building of Shanghai. Today, the government is considering the establishment of a unified inter-departmental GIS platform, to realize the purpose of public data sharing and management level improvement. Users can grasp the newest land status with the help of information technology. It allows more people to enjoy the convenience of geographic information sharing. In this context, the building of web-based land management information system has great practical significance.

## II. USER NEEDS ANALYSIS

User needs analysis is a prerequisite for the system research and development, but also is the basis for the system function modules design. No user needs analysis or not deep enough, will affect the system's utility. Each system has its own specific user. We can get the in-depth understanding of the system function and performance through the needs analysis, and know the system constraints and the interfaces with other system elements in detail. Now, with the development of computer and network, many people have been familiar with the elementary operation of web.

The main users of this system are the staff of Pudong New Area Planning and Management Center. According to user needs, the functions of Lujiazui Land Management Information System can be grouped into the following main aspects.

- Information query is one of the most important system targets, including attribute queries, information

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exchange and the attributes interoperability between maps and attributes.

- Information Visualization is very important for increasing efficiency. The query results include data tables, statistical information, maps and so on. The information can be shown with the form of charts and thematic maps, which also could be print out on paper.
- Good accuracy and reliability of data are the basic requirements. In order to meet these needs, different users should have different data manipulation privileges. A special module should be set up for data maintenance.

## III. MODEL FRAMEWORK

To enable the Web-based system can efficiently run, with strong flexibility and scalability. The three-tier system architecture was used in it, which are browser, web server, application and data server. System configuration requirements are as follows.

- Client browser should be IE6 or above.
- Web server is Internet Information Services (IIS5.0), or Apache2.0 server.
- Application and data server is formed by GeoServer, SQL Server and Chart Component.

GeoServer which is the spatial web server independently developed, realized a lot basic WebGIS functions, such as map browsing, the spatial query, thematic mapping, geocoding and tiles Map. At the same time, GeoServer also provides a wealth of Web graphics services and Web access service interface.

Developers can directly make map-related Web application development based on the http protocol interface, or client-side Ajax script library. The attribute data which is store in SQL Server database can be directly retrieval with Ajax technology. The spatial data manipulation can be achieved by GeoServer. Specific architecture is shown in the Fig.1.

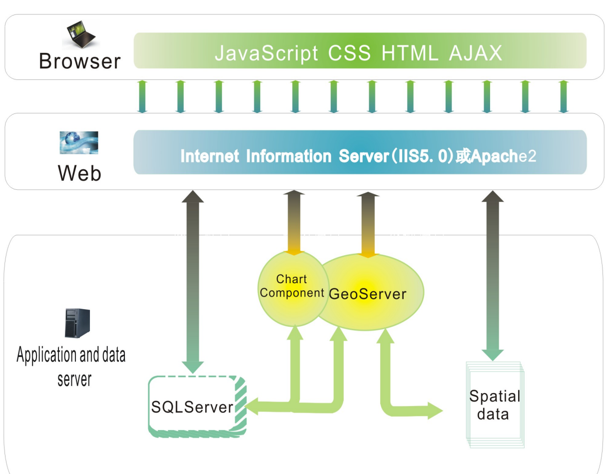


Figure 1. The architecture of the system

## IV. SYSTEM DESIGN

### A. Function Module Design

According to user business analysis, the system can be divided into planning information module, land use module, building distribution module, municipal information module and other information module. The system architecture is shown in Fig.2. The main services provided to the customers are as follows.

- Basic operation includes map display, stepless zoom, pan, eagle eye and the browser of the spatial information. Fuzzy query and precise query are realized.
- Distance calculation, area calculation, region selection and other operations are included.
- A two-way inquiry between map and property is achieved.
- Display statistical information could be shown with histogram or pie chart.
- Based on user demand, thematic maps with different information can be dynamically generated.
- Attribute table, information chart and thematic maps can be shown on screen or print out.

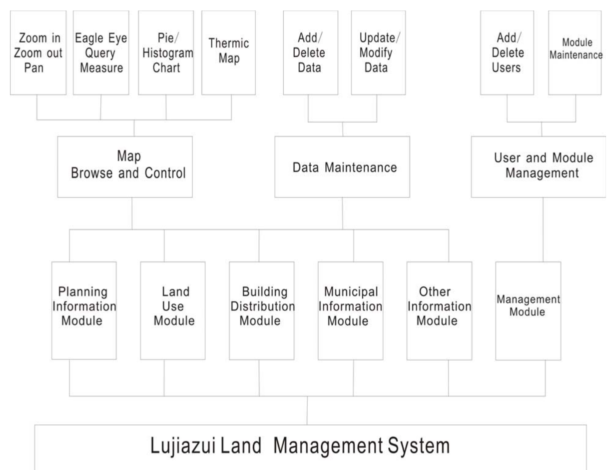


Figure 2. The architecture of the system function design

### B. Database Design and realization

#### 1) Data Classification

*a) Graphics data:* Including administrative maps, planning maps, land distribution maps and building images. The data is the spatial representation of geographic information. In order to keep the timeless of the data, the newest data was used in the system.

*b) Attribute data:* It contains a variety of statistical tables and text files. Particular, accuracy and comprehensiveness are the advantages of attribute data. But also there are some problems, such as data conflicts and information jumbled.

*2) Data Table Design*

The information of land, roads, underground pipes, and Underground Square is the main system data. It can be seen as high-dimensional data for each type of information contains multiple attributes. For that different types of data are on co-dependent block. The blockNum was set as the primary key in the land table, as foreign key in the other tables.This design is conducive to safeguarding the security and the integrity of data. According to availability and integrity requirements, the fields of land table are ownStreet, blockNum, landArea, Name, buildArea, height, et al. As shown in table 1.

TABLE I. THE STRUCTURE OF THE LAND TABLE

| Field | Memo | Type | Primary Key |
|---|---|---|---|
| blockNum | Block number | char(6) | Y |
| Name | Land name | varchar(20) | N |
| landType | Land use type | nvarchar(20) | N |
| coverArea | occupied area | float | N |
| overArea | Above-ground area | float | N |
| buildArea | Building area | float | N |
| height | Height | float | N |
| dynamic | Construction news | nvarchar(20) | N |
| ownStreet | Owned street | nvarchar(20) | N |
| parking | Carport number | int | N |

*3) Database Design*

The attribute data and spatial data are independently stored in this system. In order to meet the requirements of mass data, attribute data is stored in SQL Server 2000 and spatial data is independently stored with the file format. The two types of data can be linked together with the public field. Constrained Control was used in the database to ensure the data integrity, which could reduce conflictions during data updating.

The electric maps, which can be got through data integration, are bond with GeoServer through the Geostudio which is a kind of desktop GIS software independently developed. These electric maps as a stand-alone spatial information source are called by GeoServer in the system. This development model is more portable and flexible than traditional WebGIS system, for the reason that it needn't the support of large-scale software, such as ARCGIS Server. Attribute data can be directly called through Ajax technologies.

## C. System Safety Design

In order to meet data security and accuracy requirements, a separate module was designed in this system. The managers on different levels have separate accounts with discriminatory administrative privileges. Data browsing and data updating are operable for low-level users and high-level users respectively. Only the administrator has the privilege to supervise the users and modules.

# V. KEY TECHNOLOGIES AND ITS REALIZATION

## A. Ajax Asynchronous Interactive Technology

Asynchronous JavaScript and XML are called Ajax for short, which is a Web application development method using client-side script to exchange data with the Web server [6]. The information can be dynamically updated. This method has the advantage of reducing the user's physical and psychological waiting time. The way to request data on-demand could reduce the burden of the server. The core concept of Ajax is that adding a middle layer in the Web application. Browsers and servers interact through this middle-tier script rather than a traditional Web application in which a direct interaction is adopted [7]. WebGIS based on Ajax is able to complete the task that large amounts of data frequently and timely transmits between client and server [8]. This system can send and receive information asynchronously, which is the deficiency of the system based on ArcIMS data transfer mode.

The following codes are some samples which fills the web forms with the data adapted from database.

```
function Req2Table(url,params,toTableId,tblContId){
        _xhttp_t=getXmlhttp();
if(_xhttp_t){
    try{
        _xhttp_t.onreadystatechange=function(){
        if(_xhttp_t.readyState == 1){}
        if(_xhttp_t.readyState == 4 && (_xhttp_t.status==200
|| window.location.href.indexOf("http")==-1)){
        var oJson = parseJson(_xhttp_t.responseText);
        if(oJson.data.length >0){
        initTable(oJson,toTableId,tblContId);
        var toTable = document.getElementById(toTableId);
        if(toTable.nodeName == "TABLE"){
          JsonTbl[toTableId] = oJson;
          if(hasTablePages){
          Json2Table(JsonTbl[toTableId],toTable,0);
          showPages(JsonTbl[toTableId],toTable);
          }else{
          Json2Table(JsonTbl[toTableId],toTable);
        }}
else{alert("Create TABLE Wrong!");
        return false;}}
        else{alert("sorry, it is null");
        return false;}}}
_xhttp_t.open("POST",url,true);
_xhttp_t.setRequestHeader("Content-Type",      "application/x-www-form-urlencoded");
    _xhttp_t.send(params);
    }
    catch (err){ alert("Error in Asynchronous Transference! ERROR AT "+err);}
}}
```

## B. Stored Procedures

There will be a large number of data exchange between the client and the database including data acquisition, storage and analysis in this system. The application of stored procedure reduces the burden of data transfer, at the same time, improves system data security [9, 10, 11, 12]. Procedures written with transaction-sql language can be stored in server side. Stored procedure accepts parameters and returns results to the caller. At last, the data is passed to the client in the network.

### *C. Chart generation and the realization*

Data display methods include not only tables, but also graphics which are some of the most intuitive methods to show statistic results. In the system, user's working efficiency can be greatly improved through the histogram or pie. The graphics can be shown on screen or printed out. Some codes that enable illustrations are as follows.

```
var chart = new WebChart();
chart.setChart("400","300","BarChart");
chart.setChartXY("district ","area");
chart.setChartSQL("select ownStreet as district, sum(buildArea) as area from land group by year");
chart.setYSeriesParams("left,right","#FF0000,#00FF00","district1,area1");
chart.setRightAxis("area,4000000,2500000");
chart.setLeftAxis("district,8000000,100000");
chart.setChartTitle("TEST,#FF0000,12,");
chart.is3D(false);
chart.setChartBg("#E8D4F7","#FFFFFF","lr");
var url = _webChart;
var params = chart.getParams();
Req2Chart(url,params,"chart");
```

## VI. SYSTEM IMPLEMENTATION

The Fig.3 shows the Land Utilization which is a sub menu of land use module. Major modules are on the top of the interface. The statistical information and map are below. Zoom in, zoom out, pan, move and information query have been realized in the system. It is easy for users to get the overall distribution and the detail information of different land blocks form the thematic maps which can be dynamically generated based on user's operations.

Figure 3. The interface of the system

## VII. CONCLUSION

In the land management information system based on WebGIS, the users on different levels could operate data differently. It is a simple and complete system which can run smoothly and flexibly on internet. The only downside is that the spatial analysis capabilities of GeoServer are not strong enough, and further study is needed on this aspect. In the future, in order to promote the geographic information sharing, this system can be considered to open to ordinary people step by step. Further more, this model may play an important role on the Digital Shanghai for it could integrate with other land management systems of Shanghai.

## ACKNOWLEDGMENT

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