Design and Implementation of Highway Management System Based WebGIS

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Abstract—Network Geographic Information System is a GIS based on Web technical standards and communication protocol of network, a product of Web technology and GIS technology, it is based on Internet / Intranet to provide users with information distributed in space, data sharing, exchange and cooperation. WebGIS make full use of network resources, a large scale to reduce costs and complexity of dealing with the implementation of the server, the client is simple, is an ideal global optimization model, replace a desktop GIS system, and provide personalized service. Based on WebGIS, it is to achieve highway management scientific and effective network, it will greatly enhance the efficiency of highway management it is effective management tool to resolve the contradiction between the rapid growth of the highway and the pavement maintenance. It will provide timely and accurate decision support information.

Index Terms—highway, WebGIS, Data Sharing, B/S mode, J2EE,

I. INTRODUCTION

Pavement Management System depends on a series of tools and methods, it can help decision-making when the road need to maintain, to keep road in good condition. With the total length of highways increasing, the road maintenance needs to be strengthened. Past pavement management relies on labour statement and manual computation of statistics. The Pavement Management System has changed traditional administration method, it is a modern comprehensive management to adapt the pavement maintenance of large-scale, high speed and high quality. Pavement Management System (PMS) has become the path of conservation management planning and the importance of road maintenance investment analysis tools.

WebGIS is the Internet-based platform, client-side applications using WWW protocols running on the World Wide Web geographic information system, its core is embedded in the Geographic Information System HTTP and TCP / IP standards-based application system to achieve the Internet environment spatial information management features such as geographic information. WebGIS as compared with the traditional geographic information systems have many advantages. WebGIS make full use of network resources, a large scale to reduce costs and complexity of dealing with the implementation of the server, the client is simple, is an ideal global optimization model, replace a desktop GIS system, and provide personalized service.

The WebGIS applied to the pavement management system, combined graph of the road space with elements. User can inquire about the information of the geographical entity, but also find to meet the requirements of geographic map. Pavement test results or Pavement distress survey data, WebGIS can be used to produce clear, intuitive thematic maps, in order to provide decision makers with the most direct information support. Give full play to Internet for information dissemination extensive, high speed data update feature will greatly enhance the efficiency of road management, effective management tools will solve the backward and the rapidly growing contradiction.

II. SYSTEM DESIGN

We select MapXtreme for Java software development platform as a highway WebGIS, which is a pure Java language for Internet map server products, including the object model, maps, services, components and so on, in line with J2EE specifications.

In the system architecture, on the page (Web) browser loads a Java program (Applet). Based on MapXtreme service of process (Servlet) get a map of GIF format images, and data sources used file with the database in the combination, form of graphics is stored in document (in Tab, table storage), while the attribute information is stored in a relational database in SQL Server 2000, the two critical values using the ID to establish correspondence between entities and attributes. The establishment of the four-tier structure as shown in Figure 1 of the WebGIS platform (client tier). Web server tier application server layer and data layer. The application server and web server separate from, not only to enhance server end of the processing power and speed, while improving system stability and portability.
III. REALIZATION TECHNIQUES ANALYSIS

Network Geographic Information System is a GIS based on Web technical standards and communication protocol of network, a product of Web technology and GIS technology, it is based on Internet / Intranet to provide users with information distributed in space, data sharing, exchange and cooperation, GIS functions and service functions (such as spatial query, spatial analysis, maps, map features, etc.) of the geographic information systems. It uses Web technology to expand and improve the geographic information system, a new technology; its ultimate goal is to achieve a network of spatial information.

A. Web GIS Client

Because the current browser such as Internet Explorer does not directly support the vector format of geographical data, it must extend the browser functionality, that is dynamically loaded Web GIS client software, so that the browser has to read and deal with vector format data. WebGIS client software's basic functions, such as remote data acquisition, the basic operation using Java Applet technology, the browser using dynamic web technology. Excluding the impact of network bandwidth, using the browser vector graphics, raster graphics than using a competitive advantage, first of all vector graphics over raster graphics is more beautiful, can be zoom; be able to dynamically display map icons and map editing; the same as the operation of local data to remote data operations; to work with local data fusion operation; to have a more extensive geographical features; can afford to part of the computing power. Thus, in Web GIS client to install Java 2 plug-in, select the Java 2 Applet Viewer, ASP or JSP-expression. WebGIS client application at the completion of amplification, reduced, roaming, data request operation, at the same time able to GIS vector data, some simple analysis, such as distance, area of measuring and calculation functions.

B. Web Services Layer

Web service layer makes the main proxy (Proxy) and cache (Cache) role. WebGIS used in this structure, you can make up Java Applet technology that lack of access to local resources, adapted to a typical distributed enterprise-class network computing the composition of the structure.

In this layer, the proxy server entirely written in Java language, service orientation Servlet, local services and agency Servlets can be used to achieve Servlet technology.

C. Web GIS Application Server

The system Web Application Serve is Shown in Figure 2. It is to respond to client requests, and process the request, it sends to the client for display. In the web application server, it involved multi-user and concurrent processing requests through the Servlet and JavaBean to handle, of which the business logic using COM to deal with.

GeoServlet is a Web server running Servlet application, but it is also RMI client. The System deals with the client and Web Application Serve to receive request and transmit the request to the GIS application server for processing, then return to the application server processing results to the browser. GeoServletRequests is the Servlet interface to a service, including asking the client to the server connection, it puts these requests through remote method invocation on the GIS application server, and starts the appropriate parts to complete the task, the task passed GeoServlet, instantiated GeoServletResponse, returned to the client.

D. Web GIS Database Server

Attribute data is a specific description of spatial objects, such as the highway attribute data includes the road name, road materials, road test data, traffic images and image data, the conservation model data and so on. Highway Management System completed in various types of data, attribute data query, geographic data query and statistical functions through the GIS. According to their stored data are divided into two types of static data and dynamic data.

Static data is stored in the data remained relatively stable, once collected and inputted data, except in special circumstances essentially unchanged. Static data include: line coding, Administrative Region coding, range coding, coding sections.

Dynamic data must be based on changes in road conditions and regularly update the data. Dynamic data includes: pavement distress data, the road roughness data, road anti-slide data, history data.

The function of WebGIS database is to store the spatial data. Generally it use a relational database (RDB) or object-oriented database (OODB).Highway Management System, the core of the internal components of the system is the database. For a WebGIS management systems, database systems can be divided into two, most of the
first, the spatial database, and the other is the attribute database. To put it simply, it is that by the WebGIS spatial database to manage the electronic map, which mainly includes the management system in the geographical location of the road and all other relevant geographic information. Attribute data can be divided into the state of the road information and expert knowledge. The main road condition information include the size of the appearance of the road, the road performance of the situation; expert knowledge in the system for the road conditions Evaluation, forecasting, analysis, are given decision-making recommendations on the road to achieve conservation and scientific management.

In order to enable users to query in the road or bridges, spatial data, and graphics, it will be able to show the attribute data. We need to solve roads, bridges, and other spatial data with its attributes of the data storage, display, query and analysis of the link between. We need create key field between spatial data tables and attribute data. Through the keyword paragraph, it achieves graphics data and attribute data between the connected. The data model of system is shown in Figure 3.

**IV. MODEL FUNCTION BASE**

System to establish pavement performance evaluation model, the model library provides the data interface, the system model parameters can be optimized.

**A. Pavement Performance Evaluation Module**

Establishing a rational, comprehensive and scientific evaluation of pavement performance indicator system is to formulate a correct precondition for conservation programs. The system based on setting performance evaluation of asphalt road and the calculation model, the use of the system attribute data, according to road surface roughness, deflection, sliding coefficient, road damage, quality assessment, road indicators to evaluate integrated and comprehensive evaluation, and automatic generation of tables and charts. So that conservation and management personnel can clearly grasp the overall situation of the road, so as to road maintenance of macroeconomic policy-making to provide an accurate basis.

**TABLE I. ATTRIBUTE DATA RECORD**

<table>
<thead>
<tr>
<th>Section Name</th>
<th>Properties Materials</th>
<th>Pavement</th>
<th>Lanes</th>
<th>condition</th>
<th>Start Point</th>
<th>End Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>bjl</td>
<td>main road cement</td>
<td>8</td>
<td>Excellent</td>
<td>xxx</td>
<td>xxx</td>
<td></td>
</tr>
<tr>
<td>hnl</td>
<td>secondary road asphalt</td>
<td>4</td>
<td>good</td>
<td>xxx</td>
<td>xxx</td>
<td></td>
</tr>
<tr>
<td>jshl</td>
<td>branch gravel</td>
<td>2</td>
<td>Worse</td>
<td>xxx</td>
<td>xxx</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE II. PAVEMENT PERFORMANCE EVALUATION INDEX**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>surveys</th>
<th>evaluation</th>
<th>Composite Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flatness</td>
<td>IRI</td>
<td>RQI</td>
<td></td>
</tr>
<tr>
<td>pavement damage</td>
<td>DR</td>
<td>PCI</td>
<td></td>
</tr>
<tr>
<td>pavement strength</td>
<td>Lo</td>
<td>PSSI</td>
<td></td>
</tr>
<tr>
<td>anti-skid test</td>
<td>SFC</td>
<td>SRI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PQI</td>
</tr>
</tbody>
</table>

Pavement Quality Index (Range of 0–100) is a comprehensive reflection of the road damage, road structures and road service performance of the overall indicators.

\[
PQI = PCI \times P_1 + RQI \times P_2 + SSI \times P_3 + SRI \times P_4 \tag{1}
\]

Refer to equation (1) P1, P2, P3, P4 are the corresponding weights.

**B. highway management expert decision**

The system provides a range of analytical tools to assist users in decision-making information on the results of statistical analysis, including the use of performance indicators for comprehensive statistical analysis of road maintenance costs and the demand for statistical analysis of the project, the road long-term conservation planning statistical analysis, the cost impact analysis.

**V. CONCLUSIONS**

Highway is a linear characteristic of the entity with the road, this linear thematic maps of the geographical characteristics of highway planning, management, conservation is particularly important, it must be road and with the geographical characteristics of highway-related location information is stored into the computer.

Based on the pavement management of the highway field needs analysis, specifically to Web GIS for the new technology platform, the highway pavement management system design and build roads spatial database and attribute database, it use dynamic segmentation technology to road-related geographic information and spatial information such as road conditions have been an effective link. It use model-related Pavement Performance Evaluation to call for the highway pavement performance evaluation and prediction, and decision support subsystems with analysis and decision-making. Through the establishment of a Web GIS-based road management system, can achieve a Pavement Management System management and visualization of network information for the conservation and management departments at all levels to provide a timely and accurate decision support information, to reduce the limited highway conservation funds.
REFERENCES


Feng Xie, born in 1972, graduated from Southwest Jiaotong University, Chengdu, China. And received the Ph.D. in 2010, the major field is traffic engineering. He worked at Sichuan Vocational and Technical College of Communication, Associate Professor. He has published two articles. XIE Feng, ZHANG Peng. The Design of highway pavement management system Based on COMGIS[J]. The Second International Conference of Transportation Engineering, 2009, 3225-3230; ZHANG Peng, XIE Feng, Intercity Transport and Matthew Effect [J]. The Second International Conference of Transportation Engineering, 2009, 2546-2552.