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Design and realization of fire alarm and management system based on WebGIS

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ABSTRACT

At present, frequent fire brings about huge losses to people's life, thus it is an important research topic about how to effectively and timely extinguish fire. Now, an automatic fire alarm system has been applied in practice, meanwhile, in the text, basic theories and relevant key technologies of the WebGIS, and development and application situations of the existing fire alarm system are described in detail; in view of serious fire control delay, the text has proposed and achieved a fire alarm and management system based on a WebGIS method, with an excellent actual application effect. The fire alarm and management system can monitor fire and precisely judge fire alarm positions for real-time location, thereby greatly quickening a fire control speed, improving fire control efficiency and further reducing people's losses caused by fire.

KEYWORDS

Fire alarm; WebGIS; Location and office automation.

INTRODUCTION

With the social development, although fire-fighting measures are more and more complete, fire still frequently occurs, as the most occurrence frequency in all hazards and the very large direct economic losses. The losses are inestimable if the fire cannot be timely extinguished in its early period. Under normal circumstances, fire control time is delayed mainly due to disadvantages of the traditional fire management system. The traditional fire management system still adopts manual record and treatment methods with low efficiency, thus fire alarm signals cannot be effectively and quickly checked for authenticity so as to greatly reduce fire control efficiency[1], meanwhile, during treatment, searching for fire places and information also will cause serious delay.

At present, a geographic information system has been widely applied to various social aspects, such as urban planning, land and traffic management and the like. Almost all departments of using spatial data and information need adopt the geographic information system[2]. In the text, the geographic information system based on Web is applied to the fire alarm and management system, to improve operation efficiency during fire control and extremely reduce unnecessary fire losses upon time-real fire response. Many researches of applying the WebGIS to the fire-fighting field have been done by domestic and overseas scholars. Chun FU, from Chengdu University of Technology, has established a WebGIS management library for the fire monitoring system by using database technologies according to special actual demands, and the management library can support users (fire fighters) to quickly search and browse[3] various information from key units. Deng Fei has proposed and established a linked network fire and alarm management system, during fire occurrence, the system can quickly convert heat, light radiation, fumes and physical quantities caused by fire spread into electrical signals through a sensor and further transmit to the fire alarm equipment to record fire time and places[4]. The above systems can assist fire control strategies, shorten alarm time and reduce human error, with great significance of preventing serious and larger fire. However, the systems still have the disadvantages[5-8] of simplicity and low performance indexes. Moreover, through full utilization of high-level WebGIS geographic information, based on network and communication technologies, a scientific, precise and intelligent alarm system with high efficiency and relationship among fire information and spatial positions has been established in the text, and the system greatly improves the fire control speed and reduces fire influence on human life and property.

WEB GEOGRAPHIC INFORMATION SYSTEM (WEBGIS)

Geographic information system

The geographic information system is shortened for GIS and also called as Natural Resources and Environment Information System in China. Since the 1960s, the geographic information system started to appear and was gradually developed into a new method of researching geography and regarded as intersection of many subjects. The geographic information system as an advanced system, based on computer, database, much spatial and dynamical geographic information, provides convenience and decision services for some industries relevant to geography through geographic analysis methods. The GIS has three characteristics distinguished from other systems: the GIS has strong spatiality and dynamics and can acquire, manage, analyze and output much geographic information; the GIS is supported by the computer system to manage spatial and geographic data and can quickly, precisely and comprehensively execute spatial location and dynamic analysis to the complex geographic system; the GIS can comprehensively analyze regional space and multiple factors and dynamically forecast to generate high-level geographic information.

From the function, the geographic information system includes many systems for managing and processing relevant geographic data. From the memory, it includes professional staffs, geographic data and relevant software and hardware. The system manifests global environment and relevant attributive characters through data and creates relative models to terrestrial space and actions of various objects so as to conveniently store, manage and analyze these data in the computer. The user can conveniently

acquire these data as effective assets to research comprehensive analysis and assistant decisions in the relevant geographic industries. The system supports relevant attributes, namely the GIS is regarded as the computer system with input, treatment, consultation and analysis. It also suggests the system is regarded as the cross-discipline subject among space science, information science and earth science. Its development is closely linked with computer technology (software/hardware), remote sensing technology, information technology, geography, cartography and mapping, see Figure 1.

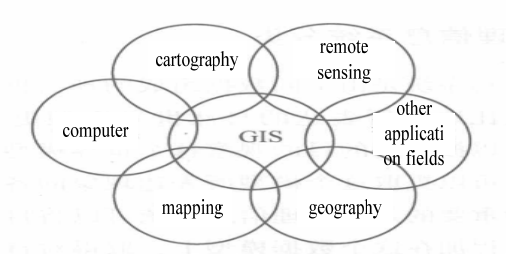

Figure 1 : Geographic information system and relevant subjects

The GIS is regarded as one computer software and hardware system and one advanced geographic spatial information model composed of computer application programs and geographic data. Staffs with geography basics as its using objects can better understand abstract geographic data displayed on the GIS, instead of meaningless things. The user can acquire any desired geographic content and knowledge according to the system, through the model, the actual process is analyzed and or forecasted. The GIS is applied to decisions and management in the actual process, with very important significance.

WebGIS introduction

The WebGIS is a new thing integrated with Internet technology and GIS, through integration, the GIS is expanded in functions so as to really become a general use tool. Because any one of nodes on WWW can conveniently browse data and relevant charts in the WebGIS and execute relevant spatial search and analysis. Through integration of said two technologies, the WebGIS can utilize its wider space to provide multiple information to the user, such as characters, dynamic videos and remote sensing images. The WebGIS is characterized by 1) global client/server application; 2) really popular GIS; 3) excellent expandability; 4) cross-platform character.

In comparison with the traditional GIS including low efficiency, high cost and uncontrolled data integrity, the WebGIS has the following advantage of wide accessibility, namely the client can simultaneously access multiple latest data in different servers such that multiple distributed data sources easily achieve data management and integration. Meanwhile the WebGIS platform has strong independence, no matter which machine is regarded as the server/client and no matter which GIS software is served as the WebGIS server, through the general web browser, the user can transparently access data from the WebGIS, dynamic combination of distributed components and cooperation and analysis of spatial data are executed by the machine or some server to share remote heterogeneous data. Besides, the WebGIS is greatly reduced in system cost and easily operated.

The WebGIS system includes three processing methods, namely client processing, server processing, and client and server combined processing, the WebGIS based on the server basically doesn’t change invoking functions of the primary GIS server to quickly and easily configure Web, with high development efficiency, but has higher requirements for the server. The system based on the WebGIS is the client program of the server on the local computer and interacted with the user, if being some simple user requests, for example map zoom, client commands demanded for processing requests are transmitted to relevant clients, and these simple requests are processed by local clients. When the user demands to process some complex requests, upon the client cannot process them, request commands are transmitted to the server and returned to the client human-compute interface after

processing. Through combination of the client and the server, different schemes can be used for processing different geographic data so as to better balance security and effects; the realization method can better solve the disadvantages of two previous realization schemes. The comparison on advantages and disadvantages of two web geographic information systems is shown as TABLE 1.

TABLE 1 : Comparison on advantages and disadvantages of two web geographic information systems

	advantage	disadvantage
WebGIS WebGIS based on server	It can quickly configure Web, with high development efficiency; it can access large database and a lot of data isn't transmitted to the user for processing through the network; it can execute complex spatial analysis and operation to ensure correct data use.	It has high requirements and heavy load to the server; raster images are returned to the user, with high network data flow and long waiting time for the user; without fully utilizing the client processing ability; any request from the client must be submitted to the map server for processing.
WebGIS WebGIS based on client	The server load is reduced so as to respond more requests; it has low data flow and high network operation efficiency; the user owns high degree freedom operation to freely process each element.	It has high requirements for the client; data transmission and small GIS routines are affected by network bandwidth to delay response and increase waiting time for the user.

Structure models of WebGIS

Generally, there are three structures of the webGIS, namely traditional client/server, browser/server and multilayer structures[11].

In the client/server structure, the application system is divided into a leading end (client) and a rear end (server), relationship between the client and the server pertains to request/correspondence one, namely the client need achieve man-machine communication and affair organization for the user, and the server processes relevant commands. Compared with the document server, the structure has high performance, and client requests and server processing functions are divided as one high-efficiency model. Achieve processing demands by the server, and realize "distributed application processing" to each client request. From a functional standpoint, the client manages user interfaces, receives data, applies logical processing, sends requests to the database, and receives and formats results. However, the server firstly receives and processes database requests, formats results and transmits data to the client. C/S two-layer structure system diagram in Figure 2.

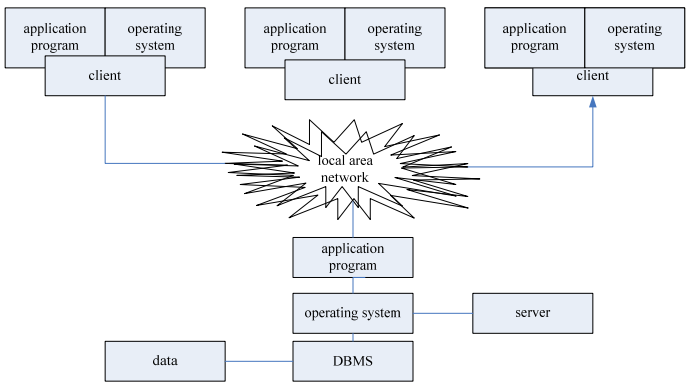

Figure 2 : C/S two-layer structure system diagram

The WebGIS browser/server structure is a three-layer system structure, including a client layer, an application logic layer and a database layer, wherein the application logic layer is composed of a Web server and a WebGIS application server. Each data layer contains different logical functions, firstly the client layer displays data results and submits relevant user requests; the application logic layer responses events and processes the user requests; the database server executes data storage, amendment, deletion and management commands. In the case, workload of the system can be reasonably distributed, thus

operation efficiency is further improved. When the client delivers the request commands, the server searches for relevant map data information and application programs to return the client, because all events are processed in the server, routine maintenance is primarily for the server. Due to combination of Web and B/S technology, the mentioned structure model is characterized by simple structure and flexible application. Moreover, see Figure 3 for model structure. However, adopt the three-layer system structure in the example.

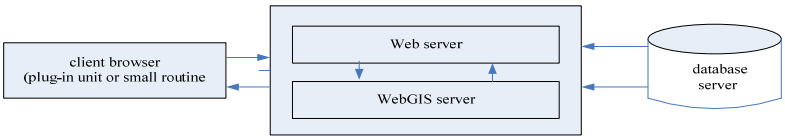

Figure 3 : Three-layer system structure of WebGIS

The multilayer structure is one model based on the middleware technology, wherein the middleware technology is regarded as one software layer defined by Application Program Interface, and transmits data between the client and the server or between the servers to communicate between the client group and the server group.

Core technologies of WebGIS

The core technologies mainly include two aspects as follows.

(1) Data standards and norms

The key to information share is the information standardization problem, while repeated things and concepts are uniformly stipulated for standardization whose essence is management. Since the ISO proposed “Reference Model of Open System Interconnect” (OSI/RM), at present, there have been above 120 formal standards of the OSI, the vast majority of international manufactures have transformed to the OSI system, according to national conditions, national governments have established relative precise protocol systems to serve individual nation by taking OSI as basic standards. With their development, ISO standardization is greatly also promoted. The geographic information standards include four aspects, such as hardware, software, data format and data set standards.

(2) Data integration and share

In an information society, a lot of geographic data from different backgrounds is generated all the time, with distributed storage. In network situations, information executes distributed processing by different software and can be timely published to the network. At the moment, the key problem is how to select excellent geographic information software so as to enable the user to quickly acquire effective data from different databases, and how to analyze and share acquired data by different systems, namely how to integrate and share them. However, to solve these problems, for one thing, the country need issue relevant laws and regulations or policies; for another thing, research on data exchange and sharing technologies among the software need be enhanced, namely data-sharing issues with different formats. However, at present, there are about data-sharing methods, namely data interoperation, data conversion and direct data access.

DESIGN OF FIRE ALARM AND MANAGEMENT SYSTEM

System design

In a broad way, because the WebGIS is a distributed geographic information system, it adopts the WebGIS technology. Through the technology, load between the client and the server can be reasonably balanced when client request commands are processed, thus the server cannot occur slow response or crash when all tasks are centralized thereon. As a general rule, dynamic extraction and analysis of data subsets are executed by the server, selection and query for spatial information and map zoom are executed by the client. The abided technical standards for configuring WebGIS system structure is shown in TABLE 2.

TABLE 2 : Abided technical standards for configuring WebGIS system structure

base technology	content
network communication protocol	TCP/IP
document and file transfer	HTTP
document display and application program integration	HTML
client integration	Plug-in,Active,Java
server integration	API. Java CGI, server API. Java
client expansion	HTML,javaScript,VBScript
server expansion	CGI, server API. Java

The fire alarm and management system includes the following main functions:

1) User management. The users using the system are treated differently, with different functions and authorities.

2) Office management. The function can manage and update some important documents, and laws and regulations. Security levels are set for these documents, different users only can access documents corresponding to identities to ensure security of data from the database. Store fire records into corresponding texts to conveniently inquire occurrence places and time in the future.

3) Data management. Store data in the system into the SQL Server2000 database and connect the database with the system in real time, to ensure real-time storage and amendment of data.

4) Facility management. The system further manages the fire fighting equipment divided into four statuses such as operation, storage, repair and abandonment. Manage the different-status equipment for real-time invocation. When some equipment is in either repair or to-be-abandoned status, the system automatically reminds administrators of relevant operations.

5) Geographic information inquiry. Inquire geographic information relevant to fire.

6) Map operation and spatial analysis. Achieve visualized map operations such as zoom, diminution and location, calculate and optimize the optimal path of the fire fighting track to the fire place.

7) Multi-media information inquiry. Achieve multi-dimensional information inquiry for fire control points.

8) Networking. Remotely control the system even if the administrators don’t operate the server.

Overall system framework

The fire alarm and management system is divided into five layers: an Internet layer, a computer system layer, a database layer, a function application layer and a human-machine interaction layer, as shown in Figure 4. The function application portion is composed of five modules, such as geography information query, facility management, office management, user management and system help modules.

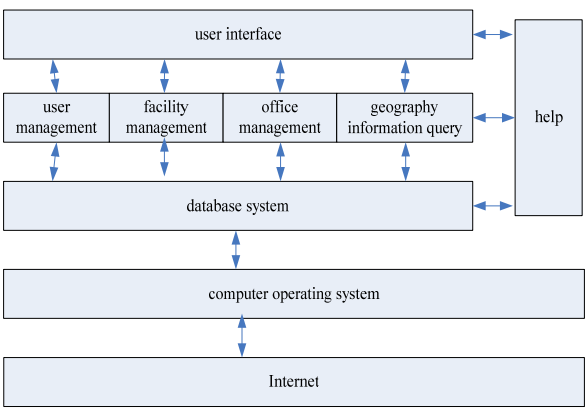

Figure 4 : Overall system structure

As previously mentioned, the system is designed into the B/S structure and developed through combination of Microsoft ASP (ActiveX Server Page) and SQL server 2000, and the geographic information portion is developed by MapXtreme software from the MapInfo company.

System realization

Geography information query module

The geography information query module is established based on the Java Applet technology, considered for database processing, servers and the network and conditions. The Applet processing procedure is that: it is transmitted from the server to the client for operation and connected with the application server through gateway interfaces, then zooms and diminishes graphs on the client based on the server data. The client interface is the HTML format page established based on the Web browser, and contents from the server can be displayed on the page. Similarly, the server is connected with the geographic information module through the gateway interfaces and transmits the commands to the geographic information module upon user request, then the commands are converted into SQL language for inquiry in the database through the module, finally one picture format document is returned to the client through the Web server.

Geographic information display

It is a very important function to display the geographic position, through the function, information and surrounding conditions of the relevant fire position can be quickly confirmed. The function is achieved by three steps: firstly, acquiring place's coordinates from the map and designing a point-getting method for achieving the process; secondly, searching for relevant displayed information according to the user's inquiry conditions; finally, marking on the map upon receipt of the demanded file information.

Point-getting method: because each one of points on the map has an unique corresponding coordinate value, the place's coordinate value can be obtained through its name or relevant marks.

File search: because geographic information of relevant fire is stored into the system database, relevant files can be obtained through coordinate values of the relevant place.

Marker: the present position can be added with relative markers for prompt as the coordinate values and the file address information are obtained.

CONCLUSION

Office automation, WebGIS and B/S methods are combined with the system, thereby achieving remote information processing and control, and fire fighting equipment and geographic information processing. Through the system, fire control calls are more reasonable and sequential. Create one time and place to timely gain fire behavior through the intelligent alarm system for fire information and spatial position, then analyze the relevant optimal path through the system so as to greatly improve the fire control speed and effectively reduce fire influence on human life and property, besides, the system is easily operated and skillfully used without professional training.

The WebGIS system can not only be applied to the fire-fighting field, but also can be suitable for railway, civil affair and other fields, similar models can be created according to the methods proposed in the text, thereby greatly improving efficiency of relevant industries and reducing losses or increasing relevant incomes.

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