Data Processing for Managing Remote Sensing Images

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Abstract

This paper discusses the establishment, management and application of remote sensing image database. A systematical structure for remote sensing image database is presented and analyzed. This architecture is based on web service technology, rather than traditional Browser/Server or Client/Server model. To process and publish mass remote sensing images on the web, appropriate system framework and software platforms are adopted in order to establish stable website and create web map service. In our system, Oracle is used to store the remote sensing images and GIS data, ArcGIS Server to create web services and accomplish web applications, and ArcSDE to manage the geospatial data. WebGIS applications and enterprise applications are carried out by utilizing and developing the geospatial database. The distributed database system provides a new model to archive and manage geospatial images effectively.

Keywords: database management, remote sensing image database, web services

1. INTRODUCTION

With the rapid development of remote sensing technology, the quantity of remote sensing images has increased sharply. Therefore, large commercial rational database management system (RDBMS) is currently adopted to store and manage remote sensing image data [1]. Besides large storage space, high-speed computational capabilities are needed to process and analyze mass remote sensing images [2]. Nowadays, some Geographic Information System (GIS) institutions and corporations have produced their own WebGIS software platform and spatial data engine to support RDBMS such as Oracle, SQL Server et al. At the same time, large GIS companies develop some software to provide web services of the geospatial data. The management and application of mass geospatial data is very important to web users. With the technologies of database and web services, mass geospatial data such as remote sensing images could be archived and managed effectively.

In our system, Oracle 10g is used to store the remote sensing images and GIS data, ArcGIS Server to create web services and accomplish web applications, and ArcSDE to manage the geospatial data. This paper discuss the establishment and management of remote sensing image database system based on web service architecture and demonstrates some applications, in which some key techniques are involved.

2. SYSTEM STRUCTURE

For the storage, management and utilization of mass remote sensing images, the traditional Client/Server architecture or Browser/Server architecture couldn't meet the demand effectively. Web service technology that is on Service-Oriented Architecture basis could enhance the application of remote sensing image database.

The W3C has defined a general-purpose web service architecture based on a trio of standards — Simple Object Access Protocol (SOAP), the Web Services Description Language (WSDL), and Universal Description, Discovery, and Integration (UDDI) [3]. Open Geospatial Consortium (OGC) has defined the Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), and OGC Web Service Architecture, which support application developers in integrating a variety of online geoprocessing and location services [4].

WebGIS (also known as web-based GIS and Internet GIS) denotes a type of Geographic Information System, whose client is implemented in a Web browser. WebGIS technology has been developed and used extensively in real-world applications. However, such a complex web-based system involves the dissemination of large volumes of data and/or massive user interactions [5]. So, a stable and effective system structure should be designed and put in practice.

GIS web service clients are traditionally heavy-duty, stand-alone software tools. This made GIS web services more difficult to build than the ordinary business transactions for which general-purpose web services are originally intended [5]. Therefore, it is necessary to build a distributed processing system in which many heterogeneous databases, networks, and applications could be properly integrated.

Fig. 1 illustrates a geospatial data distributed processing system on web services architecture basis. In Fig. 1, Geospatial databases are composed of many heterogeneous databases which are located in different department within an enterprise to store geospatial data of different format. WFS, WMS, and WCS compose the data services. WPS (Web Processing Service) Register Center is the main part of this system for managing the web services. WFS, WMS, and WCS must be registered into WPS Register Center in order to have access to image processing clients in which logical applications are performed.
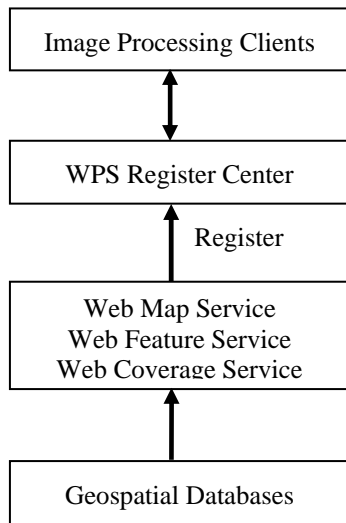
Figure 1: System structure based on web services architecture

Figure 2: Workflow for geospatial data storage, management and application

3. METHODOLOGICAL APPROACH

To build remote sensing images, the database is applied in web services architecture. Following techniques should be under consideration.

3.1 Data Processing and Uploading

Remote sensing data are temporal multi-dimensions, multi-sensors, multi-angle, multi-spectrum and multi-platform. Therefore, image processing such as data fusion, image mosaic and image enhancement should be done before uploading remote sensing image data into database. Web services architecture enables the processing of remote sensing data more easily. In the process of uploading, adjusting proper uploading parameters is of very importance.

3.2 Querying and Retrieving

It is very important to quickly and effectively query data from the database. Remote sensing data differs from other data because of its characteristics of texture, color, and spatial geometry. The query conditions include not only date, location, bands, sensors et al, but the image content as well. Consequently, query standard and retrieve mechanism based on image content should be defined.

3.3 Management and Utilization

Besides uploading and downloading, the remote sensing database should be further exploited for more utilization. With web services architecture, we develop a management information system and extend the utilization of remote sensing database from Intranet to Internet. The management information system could be based on traditional Browser/Server model, Client/Server model, or combination of these two models. With the increasing access demand of web users, web application is the first important utilization of remote sensing image database. Therefore, the management and utilization of remote sensing data should be based on web services technology.
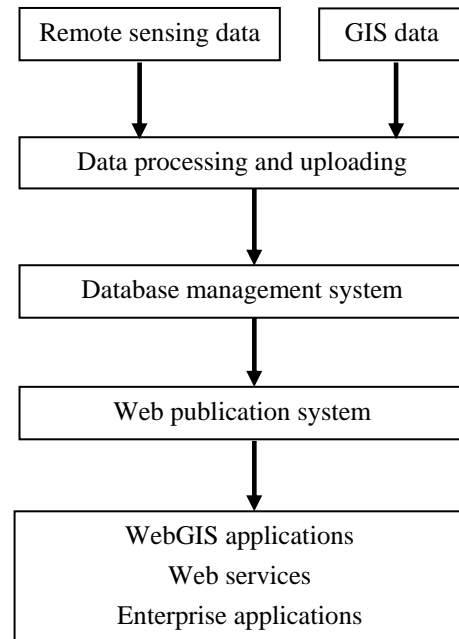
Fig. 2 illustrates the workflow for geospatial data storage, management and application. In Fig. 2, mass remote sensing image data and Geographical Information System data may be processed in different departments of an enterprise. So, it is necessary to effectively manage the immense geospatial data [6].

Generally, image processing should be done by remote sensing image processing software such as ENVI, ERDAS IMAGINE et al. In our system, ArcSDE is used to upload geospatial data to database and then establish the remote sensing image database. In order to accomplish data management functions such as adding, deleting and updating, ArcObject and programming language are used to develop Database Management System. Web publication system is established with ArcGIS Server and then web applications could be developed with programming tools such as Java language. ArcGIS Server now supports web services technology, geoprocessing and globe publishing with its Web Application Developer Framework (ADF). As the web access privileges are set properly, the WebGIS applications, Web Service, and enterprise applications for internet users, intranet users and system manager are accomplished.

4. APPLICATIONS AND RESULTS

To archive and utilize remote sensing images effectively and systematically, we integrate the database management system and web publication system. The functions of remote sensing image database management system contain display, query, update et al. Web publication system made remote sensing image available on Internet and then web users could share the database ultimately.
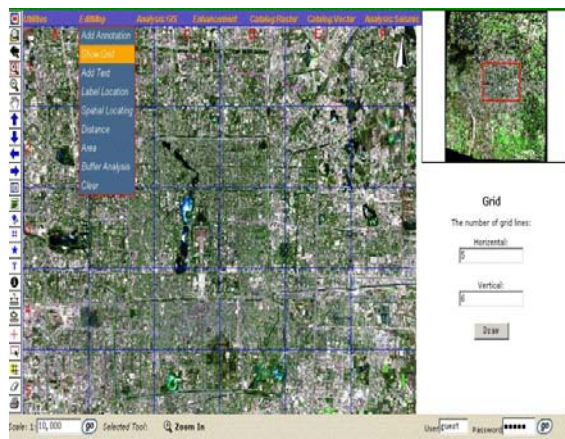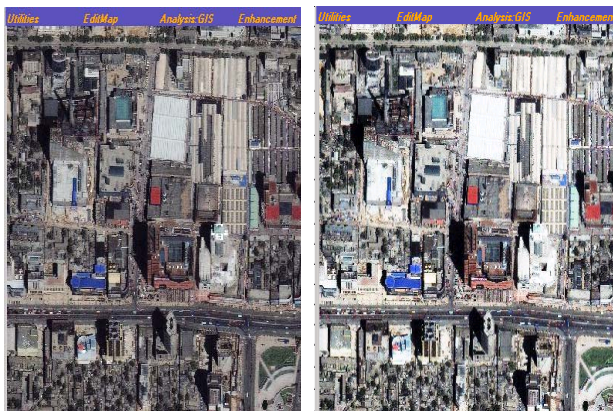
Figure 3: WebGIS application
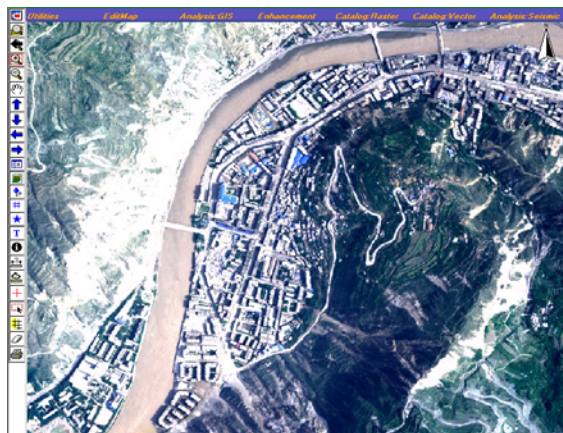

Figure 4: Online image processing

Figure 5: Enterprise application

In our system, we adopt Oracle 10g database which is commercial database software based on Grid technology. Data management such as uploading, updating and maintenance could be completed by developing ArcSDE software within internal network. Retrieving remote sensing images on Internet could be carried out with WebGIS software. The benefits of Web Service lie in facilitating web users to have access to GIS data and remote sensing images data stored in many database. These capabilities extend the power of geographic and descriptive data presentation, and provide the most flexible web publishing solution.

Fig.3, Fig.4, and Fig.5 illustrate some web applications of the distributed remote sensing image database.

Fig.3 represents WebGIS application. As the Fig.3 shows, the web publishing system provides online map edit such as adding annotation, adding grid, adding text, spatial locating, measuring distance, measuring area, buffering and so on.

Fig. 4 represents the function of online image processing. In Fig. 4, the left one is an original image and the right one is the enhanced image of the left one. The image processing clients could make these steps done according to the scheduler program of Web Processing Service (WPS) Register Center.

Fig.5 represents an enterprise application. It is a post-earthquake remote sensing image. Therefore, Web users could be well informed of the latest earthquake information and their applications. The web publication of mass earthquake information could help evaluate earthquake disaster and shorten time of first aid.

5. CONCLUSIONS

This paper discusses some techniques in archiving and managing mass remote sensing images. A distributed system structure based on web services technology is presented. In our system, geospatial images stored in Oracle database could be accessed, processed and managed using web services structure. WebGIS software platform ArcGIS Server and spatial data engine ArcSDE are utilized to publish mass remote sensing images on the Internet. The web services architecture provides a new model and powerful support for remote sensing images' distributed processing, management and web application.

6. REFERENCES

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