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The Study on Information Extraction Technology of Seismic Damage

[1,2]Huang Zuo-wei, [1]Huang Yuan-jiang and [2]Qiu Luo
[1]School of Architecture and Urban Planning, Hunan University of Technology, Zhuzhou 412008, China
[2]School of Geosciences and Information-Physics, Central South University, Changsha 410083, China

Abstract: In order to improve the information extraction technology of seismic damage assessment and information publishing of earthquake damage. Based on past earthquake experience it was constructed technical flow of earthquake damage assessment rapidly, this study, take Yushu earthquake as example, studies the framework and establishment of the information service system by means of Arc IMS and distributed database technology. It analysis some key technologies, build web publishing architecture of massive remote sensing images. The system implements joint application of remote sensing image processing technology, database technology and Web GIS technology, the result could provide the important basis for earthquake damage assessment, emergency management and rescue mission.

Keywords: Arc IMS, disaster monitoring and assessment, information extraction, remote sensing

INTRODUCTION

Earthquake is one of the major natural disasters in China. In particular, the sudden, devastating disaster caused by a strong earthquake will bring great harm to life and property. But the occurring time and location of the earthquake still cannot be predicted timely and accurately before the earthquake, so that active defense measures should be taken to reduce the disaster degree. Rapid and comprehensive access to disaster information after the earthquake is of great significance to carry out rescue actions and reduce disaster losses. For example, in Japan Nioki and Furmio (2000) used aerial remote sensing image to investigate the damage of Kobe Earthquake (Nioki and Furmio, 2000; Sun *et al*., 2008). In Turkey Earthquake, Athens Earthquake in Greece, Sumatra Earthquake Tsunami in Indonesia and Haiti Earthquake, remote sensing technology were used to investigate and assess the damage situation and the losses after the earthquake. In modern times with the rapidly development of the computer network technology and high-resolution satellite sensors, remote sensing image processing technology has substantially enhanced its capacity of the rapid access to disaster information (Xie *et al*., 2009).

METHODOLOGY

At 7:49 am on April 14 2010, an earthquake happened (33.2°N, 96.6°E) near Jiegu Town, Yushu Tibetan Autonomous Prefecture, Qinghai Province, China. According to the three elements of Yushu Earthquake published by China Earthquake Administrator, Detailed information for the adopted data is: SPOT-5 ortho-image and“Beijing-1”image data, 1:50000 scale fundamental geographic data, field work data from State Bureau of Surveying and Mapping and Ministry of Land and Resources, population data, social economic data, hydrological data, geological data, etc. Based on these geographical spatial data, it establish uniform data integration framework, so that we can conduct data format conversion, the projection transformation, geography association, remote sensing image enhancement, establishing spatial index relationship. In order to process remote sensing image rapidly, shorten the data processing time, based on distributed database it design remote sensing image processing platform (Fig. 1).

The preprocessing includes image enhancement, image transformation, fast geometric rectification, image registration, image fusion, projection transformation, image mosaicking, DOM production, etc. By geo-object association on the interpreted objects, non-spatial data spatialization, thematic data registry and space-time consistence processing, spatial index generation, the disaster situation information including texts, statistics, images and multimedia is seamlessly integrated at the same time it ensure the image file have the only right coordinates after the processing and are stored in a same directory. Foundation database including GIS vector database, remote sensing image library, which are built by Oracle 9.0 and Arc SDE. Collaborative management system is

Corresponding Author: Huang Zuo-wei, School of Architecture and Urban Planning, Hunan University of Technology, Zhuzhou 412008, China

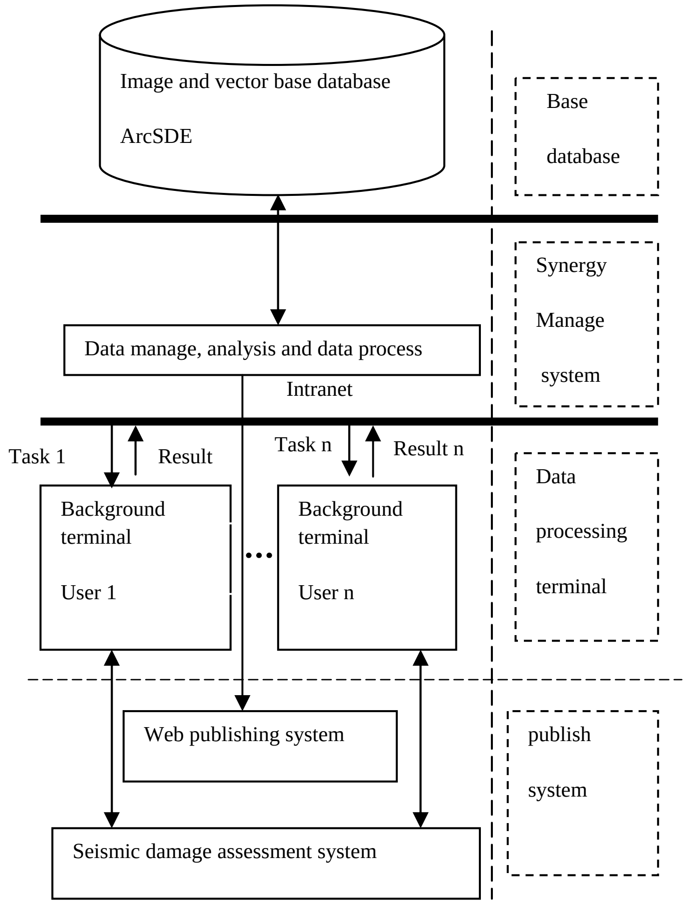

Fig. 1: The chart of database processing structure

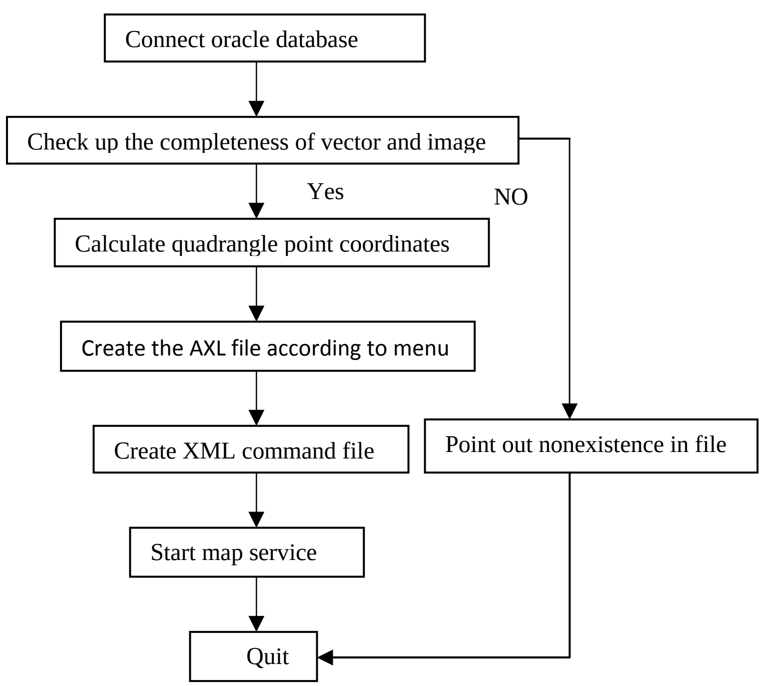

Fig. 2: Flow chart of map service

achieved by ESRI company Arc Engine second development of ESRI company according to issued task of the Collaborative management system, Data operator upload the processing results to system ,and then the administrator upload the final damage identification and damage assessment results to network publishing system (Chen *et al.*, 2008; Wen *et al.*, 2003).

Key technology:

Automatically creating map service: Creating maps service automatically is one of the key step in order to realize the seismic damage assessment rapidly and earthquake damage information releasing in real-time, it can realize the dynamic update of map service. To ensure the stability of the system and data security this system using C/S structure model., It adopted flow chart (Fig. 2) to realize create Web mapping service function automatically. Using for manage the map service, Arc IMS application server have a series of command. To perform these commands, in general it should have XML files of recorded Admin CMD command and batch files or script file. And then adding commands of start, stop, delete Arc IMS service of XML files, created a command file, and then run the file. After create a new map service chuanjian. XML documents, it can write the file dynamically in the automatic service program, then add the following command code: Service CMD = "C: \ Program Files\Arc IMS\Jre\bin\Java. Exe Com. Esri. Aims. Admin. CMD. Exec http://webserver admin file" and chuanjian. XML.
Run the command, new map service start.

3D GIS building based on VQT (Virtual Quadtree): 3D GIS technology is useful to the earthquake relief and also a powerful assisting tool for remote sensing image interpretation. The main drawback of the traditional quadtree data organization model of 3D GIS lies in its close coupling between data organized way and data storage way. On the contrary virtual quadtree brings it separate. It only build quadtree organizational framework of spatial data and not care about the data storage way and storage location. By means of mounting the spatial data adhere to virtual quadtree, so it set up the pyramid model of multilevel spatial data.VQT has two types of node:

- **Information node (iqnode):** The backbone of VQT and not include specific spatial data.
- **Data node (dqnode):** specific data storage space. It mounts to iqnode nodes by means of registration, combine into the VQT structure, then forms the pyramid model of multilevel massive spatial data.

In order to build the quadtree structure and mount spatial data, Iqnode provides a series of properties and methods. The main properties and methods are as follows:

Scale (): It records the scale and resolution of the current in mounting iqnode data.

Data location (): It records the storage path of the current mounting iqnode data.

Visit (): It used to access the spatial data of data location attribute.

Load (): It implements the Mounting way of spatial data move to the iqnode node. When there is spatial data move to iqnode, Iqnode call Load method and then the spatial data storage path will be registered to iqnode node. When some system access iqnode nodes data, it calls Visit methods to Visit the spatial data of data Location route.

Unload (): It implement the unload method of spatial data.

Dqnode data node may be a data node, or it may be a centralized Quadtree. Aim to the dqnode integrated into the VQT Seamlessly, dqnode needs to provide a unified data format and data access methods, such as WMS, WFS and so on. Virtual Quad Tree registration mechanism make it easier when deal with subtree mounting of quad tree and double tree Fusion algorithm, it need not data replication and will not damage the original quad tree structure due to Data coverage.

For example: If we think Subtree td from B point of VQT-II node fusion and replace Subtree sd from A point of VQT-I node. It only need to unload subtree sd from A node and bring the subtree of B node mount tonode A. Double tree fusion algorithm as shown in Fig. 3.

Overlapping display of image data with vector data in different coordinate systems: If the image data with vector data can be overlapping display, then the

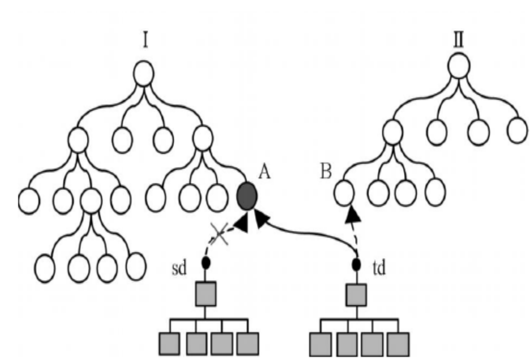

Fig. 3: Two trees merge chart of quadtree

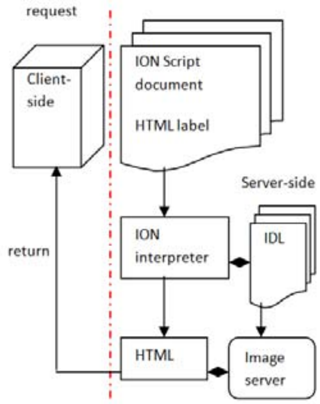

Fig. 4: Network image process flow of ION script

information of seismic damage area will be display more vivid and visualized, it provided for rapid disaster assessment and emergency command ability. If it was used the same projection coordinate system, the overlapping display is no problem, if not, we must conduct projection coordinate transformation, but there are many kinds of projection pattern and Arc Map, image and vector overlapping display tools, automatically loading the map projection to the pattern of the first loaded after map converting, as there is drawback of network delay, Arc IMS is not displayed in accordance with the Arc Map, but the true projection of the original map. To solve this problem, the image map service and vector map service is relatively independent of the application program, on the map window we

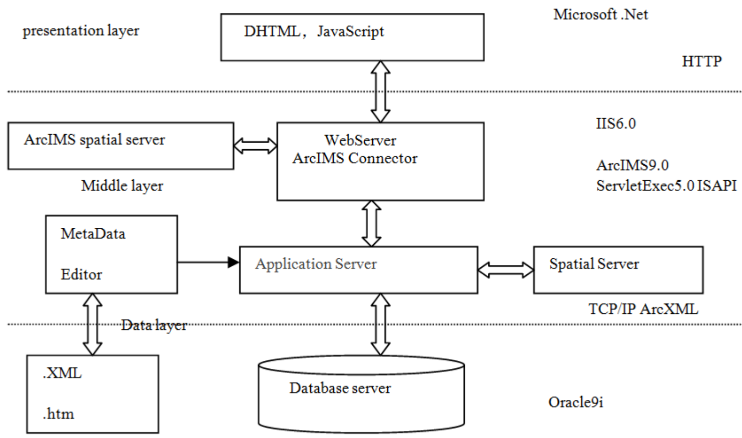

Fig. 5: Structure chart of the system

submitted two map services to the Arc IMS Application Server at the same time, when displaying vector map overlay on above of the image map, setting background color of the vector map to transparent: Map Vector. Set Background ("255.255.255"), you can see the lower layer image, while computing the four corners coordinate of the image map, and then transformed into the same coordinates of the vector coordinate system, so that screen coordinates corresponding to image coordinates and vector coordinates In this way, it not only realize overlapping display of image data with vector data at the web browser-side, but also ensure the consistency of the presentation layer.

Network image processing technology based on ION: IDL, the product of RSI company, based on Internet scientific visualization development tools, has a lot of analysis toolkit, map projection and software switch package, adopting high speed graphic image processing technology, which can quickly realize image processing function and image classification function. ION Script adopts CGI network realization mode, in general it is comprised by ION Script and ION Java and can be used alone, also can combine to generate IDL application in interactive environment, take advantage of HTML language and Java script language, it can be easily developed network information service system. Through Script interpreter in the ION server it will convert ION script into HTML language, Script application is a dynamic output HTML page, the network image processing flow is shown in Fig. 4

ASSESSMENT AND INFORMATION SERVICE SYSTEM CONSTRUCTION

The platform and system structure: The selected platform must support large amount of information releasing and well-stability aim to AST amounts of information during the time of information analysis and processing. Considering the requirement of earthquake damage assessment timeliness, the system should possess database management, query function, spatial analysis and the display function of spatial characteristics. Web GIS platform: ArcIMS9.0; Servlet engine: ServletExec5.0 ISAPI; Remote sensing image processing: ENVI/IDL, database management platform: Oracle9i; Web Server platform: IIS6.0; The spatial data engine: ArcSDE9.0 for Oracle9i.

This system using three-tier architecture, the structure model: client+WebGIS server/application server + database. According to the system characteristics and the functional requirements, the whole information system is illustrated in Fig. 5. In general, the client do not interact with the database directly, but to establish a connection through the COM/DCOM communication with the middle layer, by means of middle layer processing the application program put the task such as operation rules, data access, legality verification into practice. The three-tier architecture emphasizes the stability, ductility and efficiency which reduce the network load effectively and enhance the database response speed, it facilitates management and maintenance of the system. In a distributed system construction of B/S computing environment, the users through the browser access to server-side map service, through the TCP/IP, ArcXML communications between the Web Server, Application Server and Database Server, it achieves map service and data share in a distributed environment.

Application: Based on Erdas/Idand and Arc GIS engine, using B/S structure, the service system integrates information services for seismic damage assessment and information releasing quickly. In the form of thematic maps, reports and some other forms the results reported to the decision and command department timely, it provides the important basis for emergency management and rescue mission.

- Civil structure housing almost fell destroyed completely
- Few brick buildings collapsed
- Few civil structure housings collapsed

The 3D interface after earthquake is shown in Fig. 6. The collapsed housing in Jiegu Town is shown in Fig. 8. In the western region of Victory Road, especially in the southern section (Fig. 7a), the damage was so serious that almost all of the civil engineering structures

Fig. 6: The interface of seismic damage assessment and information releasing system

Fig. 7: Map of collapsed housing in Jiegu town
(a) Region of the South of Jiegu town
(b) Building of frame construction along the Provincial and county roads
(c) Collapse of housing on the alluvial fan

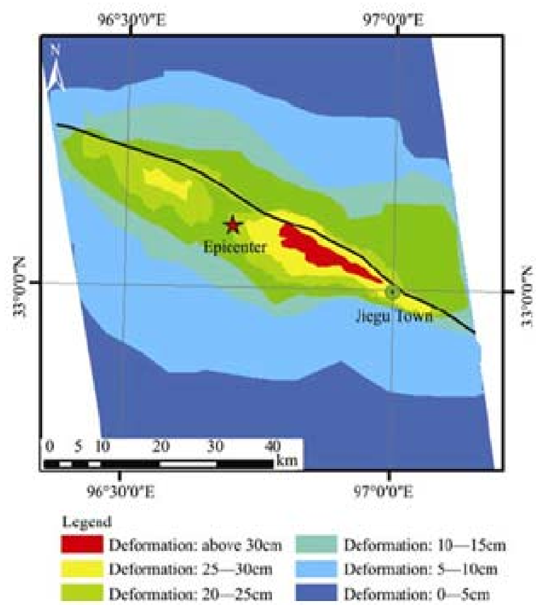

Fig. 8: Interpretation map of seismic ground deformation in Yushu earthquake

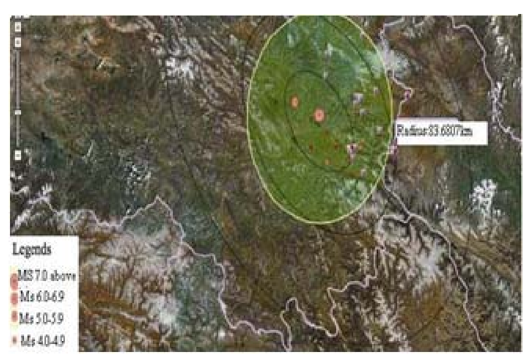

Fig. 9: Integration of earthquake intensity information and spatial information

housing fell destroyed completely. Some of the brick building was also collapsed. Many of the uncollapsed ones suffered serious damage to the structure, which are difficult to repair. For frame structure, the office buildings for government and the services buildings along the provincial and national highway were almost in good condition (Fig. 7b). The collapse rate of the housings on an alluvial fan in the west side of Jiegu Town (Fig. 7c) reached up to 86%.
There might be two reasons:

- In that alluvial fan after years of weathering, the surface was relatively flat and solid, but the lower soil had been eroded, so that the structure was not stable enough.
- The region was near the fault zone. Therefore, for the post-disaster reconstruction and the future residential land, we should keep away from the alluvial fan.

The interpretation map of seismic deformation can be obtained (Fig. 8). From the interpretation map, it can be found that the earthquake caused different degrees of co-seismic ground deformation between 32°48-33°20'N and 96°20-97°12'E. The surface rupture zone from the Longbao town in the northwest to the Jiegu town in the southeast reached 70 km long. The overall trend was 119°. The nearer from the Yushu-Ganzi surface fault zone, the greater the ground deformation. The deformation gradient was larger in the northeast direction and was relatively smaller in the southwest direction. The integration of earthquake intensity information and spatial information is shown in Fig. 9. The sensible radius is 83.6807 km.

CONCLUSION

On the basis of the practical work in Yushu Earthquake disaster situation monitoring, this paper puts the emphasis on the methods and technical flow of image processing in the application of monitoring and assessment of earthquake disaster situation. The existing problems are also analyzed. In modern times remote sensing technology provides a quick effective approach to access the disaster information and loss after the earthquake, owing to its advantage of the quick dynamically all-weather monitoring with large amount of information and a short update cycle. It provides services directly to the professional sectors for the earthquake analysis and evaluation. This data are processed and then are used in the information service system construction to realize the interpretation, assessment and service for the comprehensive disaster situation information. The system plays an important role in disaster relief actions.

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