RESEARCH AND DEVELOPMENT OF FIELD DATA COLLECTING SYNCHRONOUSLY SYSTEM OF MINING AREA

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1. INTRODUCTION

The ground subsidence and surface collapse is common in the mining area. The major cause for surface deformation is a wide range of mined-out space underground caused by coal mining [1]. While the surface subsidence, landslides and other geological disasters have a serious impact on mine production activities and people's life. It is very important to know well the changing situation of ground surface for analyzing and predicting the change trends of ground subsidence, helping for adjusting the way of exploitation and planning of land use in the mining area, and reducing the hazards of surface deformation. So it is necessary to design a field data collecting system which applies to mining area data acquisition. The system should acquire the deformation data with high precision, and could upload the collected data to the server remotely by using wireless network. At present, there are many field data collecting systems. Most of them collect data at field, and copy data from PDA to server machine manually when the surveyors come back to their offices. This procedure is very slow when the survey task is heavy, and it will need more storage space to save data at field. Now ArcGIS Server has provided the Web Map Services. Following this mechanism, the client side can update server data remotely. Just according this idea, the paper presented a mining area Field Data Collecting Synchronously System (FDCSS). In section II, the paper gave the system architecture design, functions design, and data organization mechanism. Section III introduced the critical technologies that were used in the FDCSS. Section IV gave the implementation interfaces at Yanzhou Coal Mining Company Limited mining area. The FDCSS's idea will provide a new procedure for the mining area's deformation data collection.

2. SYSTEM DESIGN

2.1. Mining Deformation Data Types

In mining area, the deformation data that need to be collected include the ranges of subsidence or collapse area, the monitor control points' three-dimension coordinates, the related attribute data, field photographs and so on. These data can be classified as spatial data and property data. In order to improve the survey precision, we can use the GPS Continuously Operating Reference Station (CORS) and Real-Time Kinematic (RTK) technologies to collect these spatial data. Yanzhou Coal Mining Company Limited has build up a single

CORS station. We can use this station to get GPS differential correction data for surveying the fixed monitor points in the subsidence areas or the subsidence ranges.

2.2. System Architecture

In order to get the mining deformation data efficiently from the field, we introduced the latest technologies and developed a field deformation data collection system. Fig. 1 shows the architecture of this system.

Figure 1. System architecture.

According to the design, the system can be divided as three parts: server side data management sub-system, client side data collection sub-system, intermediate communication links. At the server side, we used ArcSDE and Oracle database for managing the spatial data and the property data. In order to update the spatial data from client side, we published the vector subsidence area layers as Web Map Services which will be accessed by the client sub-system.

At the client side, such as a mobile device, we adopted the SQL CE as the embedded database to manage the attribute data which are collected from the field. For the spatial data collection, we used the wireless network, such as the GPRS and Internet, to access the Mobile Map Services which are published by the server side. After the data acquisition procedure has finished by using the client side data collection sub-system. The spatial data will be updated to the server side's map layers in ArcSDE by using the published Map Services, and the attribute data will be updated to the Oracle database by the Web Services which are published on the server side.

Beside the automatic data updating procedure by using Web Services, we also provided another way for data uploading. That is to use the C/S mode on PC computer when we process data in the office. When the mobile device has been connected to the PC computer, we just started the data uploading sub-system to import the field collected data to the server side database.

2.3. Client Side Sub-system Functions

According to FDCSS's architecture design, the client side data collection sub-system is more important and complicated than other parts. We designed many functions for this sub-system. Those functions include project creating and management, spatial reference setting, GPS data acquisition, spatial data coordinate transformation, map service connection, subsidence attribute data acquisition, field data updating, GPS device controlling, embedded database management, map viewing and operation, field photo taking, and so on.

2.4. Data Organization

The field collected data include spatial data and attribute data. The spatial data are stored in the mobile map which can be acquired from the Map Services on the server or the Map Cache stored in the mobile device. The Map Cache is created from Map Service by ESRI ArcTools or by ArcGIS Mobile from the wireless network. There are several layers in the Map Cache which are point layer, line layer and polygon layer. When you collect spatial data in the field, you must specify which layer can be edited. The Map Cache can also contain raster layers, but only those vector layers which are from the ArcSDE can be set as editable.

Another kind of map used in our system is called as Base Map which is created from ESRI map document (MXD file). All the layers stored in Base Map can not be edited. Both the Map Cache files and the Base Map files have been compressed greatly, they are much smaller than their data sources.

The attribute data are managed in the SQL CE database. From the mobile device side, it is impossible to access the Oracle database at the server side. In order to query or update attribute data with server database efficiently, we created Web Services at server side, and called the Web Service methods to realize the attribute data query or updating procedure.

3. SYSTEM IMPLEMENT

Fig. 2 shows the software environment of the FDCSS. At the server side, the database Oracle manages all the data, and the spatial DB Engine is used to operate the spatial data. The ArcGIS Server publishes map services which support mobile GIS access. At the mobile side, the system gets map data from the map service through the use of ArcGIS Mobile, and the coordinate data collected in field stored in the map layers. The attribute data had been stored in embedded database. Since the PDA's functions are limited, it can't operate the data in the Oracle directly. So the system will call the web services methods published on the server to update data. The field synchronous data collecting system of mining area surface deformation information based on wireless network supports Windows CE version 5.0 and later. It is easy to use the system to collect data of mining area surface deformation and update the data instantly to server by map services and web services through the wireless network. The system can get high accuracy positioning data by differential technology. And the system will convert the coordinate data from WGS 84 coordinate system to the specified coordinate system in the project.

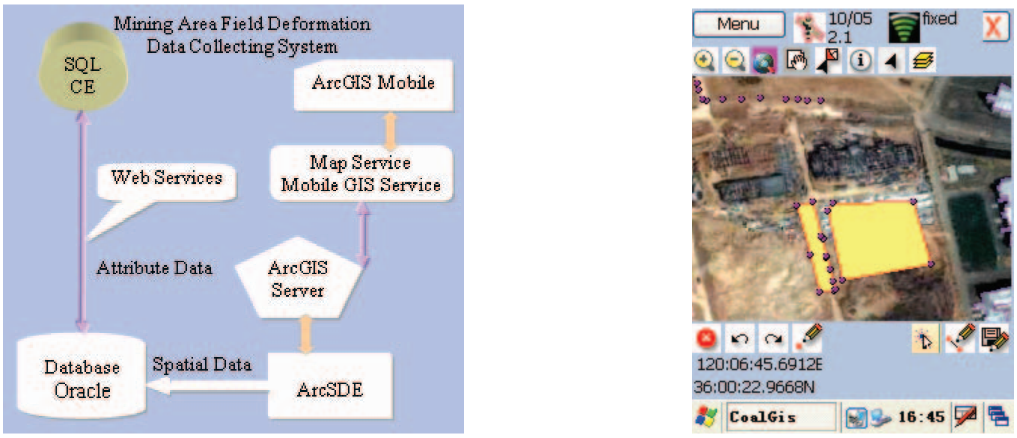

Figure 2. The software environment of the System and System Interface

4. CONCLUSIONS

The ground surface deformation has becoming a serious issue for the mining area. In order to acquire the deformation data more quickly and efficiently, this paper presented the field deformation data collecting system. By introducing the mobile GIS, Web Service, Map Service, GPS differential correction, and wireless communication technologies, the system can collect the spatial data with higher precision, and can update the collected data to server database remotely. This will accelerate the data acquisition procedure in the mining area, and can provide the latest data for analyzing the changing situation of ground subsidence.

5. REFERENCES

[1] G. Liu, H. Guo, R. Hanssen, Z. Perski, X. Li, H. Yue, and et al. “The Application of InSar Technology to Mining Area Subsidence Monitoring,” Remote Sensing For Land & Resources, vol. 76, pp. 51-52, June 2008.
[2] S. Zhang, Y. Fang, Development and Significance of Micro-Embedded GIS Software. Journal of Image and Graphics, vol 6, pp.901-904, Sep. 2001.
[3] J. de la Beaujardiere, OGC Web Map Service Interface, Technical report, OGC, 2004, pp.34-36.
[4] J. Feng and Y. Wang, “Research on WebGIS based on Web services,” Journal of North China Electric Power University, vol. 33, Issue 3, pp. 101-104, June 2006.
[5] J.G. McNeff, “The Global Positioning System,” IEEE Transactions on Microwave Theory and Techniques, vol. 50, Issue 3, pp. 645-652, Mar. 2002.
[6] T. Kato, Y. Terada, M. Kinoshita, H. Kakimoto, H. Isshiki, M. Matsuishi, and et al. “Real time observation tsunami by RTK-GPS,” Earth, Planets and Space, vol. 52, pp. 841–845, Nov. 2000.
[7] F. Zhang, H. Zhang, C. Zhao, L. Meng, X. Lu,. Control Surveying, China Coal Industry Publishing House, Beijing, 1999, pp.235-251.
[8] ESRI, ArcGIS Mobile Overview, Califonia, America. http://www.esri.com/software/arcgis/arcgismobile/index.html, 2007
[9] S. A. McIlraith, T. C. Son, and H. Zeng, “Semantic Web Services,” IEEE Intelligent Systems, vol. 16, pp. 46-53, April 2001.