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Design and Implementation of the Urban and Rural Development Monitoring System

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Abstract. Urban and Rural Development Monitoring System is a GIS technology based one featuring dynamic monitoring rural and urban development process. It uses the ARIMA model to perform forecasting and alerting functionality, and displays the various social development models' results using 3D technology. This paper describes the design ideas and system architecture for the application. Because the system integrates a large number of heterogeneous data sources including quite a few of spatial data, the paper describes mainly how to collect data, store the data, utilize the data, and visualize the data more effectively.

Keywords: component; GIS; system architecture; 3D; spatial data

1. Introduction

Since the reform started and opening-policy was carried out in China several decades ago, the ratio of urbanization has been leading ceaselessly lifting. People in China enjoy their life standards being improved significantly. Nevertheless, until now we still have not built an efficient information technology system to support, coordinate, and oversee the overall planning and developing activities for cities and countryside in a more reasonable way. Therefore it is necessary to design and implement a system designated for monitoring urbanization and township construction dynamically, to provide great decision support to the urban and rural development so that the society is able to enjoy the sustainable development.

2. System Structure

2.1. System Overview

The urban and rural dynamic monitoring system consists of social development evaluation function, data visualization function, and alerting function. These functions focus on analyzing and visualizing main or critical factors that impact on the sustainable development of a region. The system is responsible for monitoring, evaluating, and displaying the corresponding data for these factors. Furthermore, it is also acts as an alert system to ensure that any abnormal data of any of these factors will get proper attentions. These critical factors come from ecological, social, and economic areas.

2.2. System Architecture

This system is the traditional C / S structure that contains three tiers as shown in Fig.1:

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2.3. Database Tier

Database layer is the fundamental infrastructure of the system. It connected with the data warehouse directly. It includes data collecting, data storing, dynamic monitoring, and related data processing functions.

2.4. Business Logic Tier

Business logic layer consists of associated simulation model, the social development evaluation, and the related alerting functions. In this layer, ARIMA model is used to perform data analysis and prediction.

2.5. Presentation Tier

The presentation tier provides the interfaces for performing various analytical functions including the simulation of regional development trends and related evaluations. According to the information provided by the alerting system, an user is able to simulate regional trend of development and to set up comprehensive regulations.

2.6. System Functional Modules

The entire system functionality can be divided into three major modules as show in Fig. 2:

2.7. Regional Profile Module

Regional profile module mainly shows the basic geographic information of concerned regions including the following aspects.

- Administrative districts: displaying administrative district data of the region to be monitored and the data can be subdivided further into sub-districts if applicable.
- Remote sensing imagery data: including the data from Google network services.
- Topography.

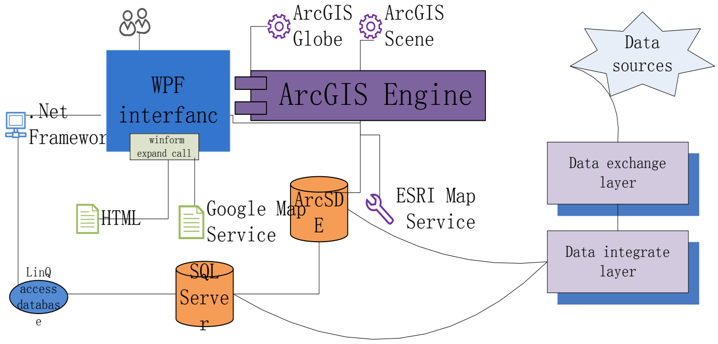

Fig. 1 High level system architecture

- Road network: including two sources for the network data (the local street data files and network data from Google maps).

2.8. Urban and rural Districting Module

It mainly uses of various data, especially remote sensing imagery data showing the boundary between urban and rural areas; this feature can display the results of the current urban-rural division for the underlying region including a statistical chart which represents the number of the urban and rural areas of the region. A map legend is employed to represent different types of areas.

2.9. Evaluation Module

This module includes:

- Evaluation data import, export, and exchange: it utilizes the predefined data and software interfaces for collection, exchange, and integration of data from various sources. We must point out that these data sources are heterogeneous, which are from different databases or data files.
- Evaluation data visualization: it shows different aspects of regional development by deploying a variety of presentations such as chart, tables, etc. to display the results.

- Data analysis: it uses the embedded data mining techniques to find out the correlation and the hierarchical structures between different factors that impact the social development and evolution.
- Prediction and alerting function: it uses the ARIMA model to simulate and forecast regional developing trends, and to provide a reference for the decision-making.

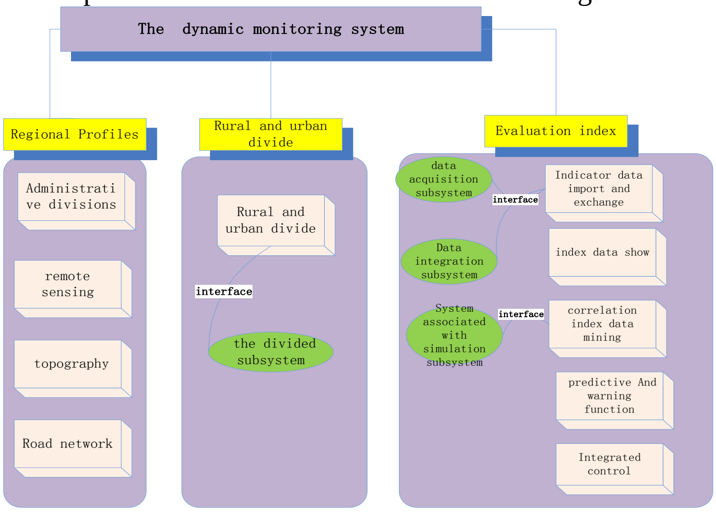

Fig. 2 Functional Modules

3. Data Processing

Urban and rural development dynamic monitoring system is a platform integrating required data from different data sources. Due to the diversity and complexity of the data, the process of data collection and integration, data storage, and data visualization become the critical portions in implementing the system.

3.1. Data acquisition and Integration

In order to create a system in accordance with uniformed standards for data classification, identification, and description, and to meet the need of data sharing, exchanging, application, and maintenance, the following functions and mechanism related to the data collection and integration are created in the system:

- Simple data accessing: Ordinary users and administrators can receive services of data directory and manage directory through the browser on the client.
- Data accessing via application service: it is the key module to support directory services platform features and applications, which includes web server and directory server. Web Server is the middle layer between a directory server and browser client. It is responsible for receiving user requests, transferring related services, and returning processed results to the user. It shields the implementation details of the directory server and the complex user interfaces providing uniform and friendly interface. Metadata: the directory database is the basis of the data service platform, which stores all the dynamic monitoring metadata, i.e., the data about the monitoring data.
- Data source management: Data source management includes managing all digital and non-digital information resources. Directory server and data source are not directly linked, but they are connected through the registration information recorded in metadata. After the user gets location information, data sources can be directly connected, downloaded, or searched.
- Data exchanging: this is the data standardization and analysis component for metadata, data extraction, statistical simplification, data interpretation, and data mining.
- Data integration: According to a particular demand, it can perform of the data integration tasks for heterogeneous sources.

3.2. Spatial Data Storage

Because the traditional database data is lack of the capability of storing spatial data directly, the system employs ArcSDE spatial database storage technology. ArcSDE converts user's request for spatial data to non-relational data. Each region dataset corresponds to a Feature Class dataset. Its administrative base maps, topographic maps (contour, TIN) are placed in the corresponding Feature Class dataset. Since the remote sensing imagery data requires a separated data format defined as a Raster Feature Class. The remote sensing imagery data is stored according to different years and different areas. All of these geographic datasets are stored in a single working space and they are stored in SQL Server database by the mapping function of ArcSDE. The spatial database and the relational database share one database instance. This is more favorable for load balancing.

3.3. Data Visualization in Three-Dimensional Mode

This system uses 3D technology to display evaluation data more intuitive as shown in the following picture, Fig.3:

3.4. WPF 3D Technology

We use WPF 3D technology to develop 3D earth model to represent the evaluation for a region’s development that can be characterized by three major factors: social, economic, and ecologic. The entire representation space is divided into eight quadrants by the earth model, each quadrant of the three axes indicates economic, ecological and social reference axis respectively.

Usually, a data chart is drawn with the coordinates for data points, but here we use the slopes (change rates) of datasets over years in the underlying region, so a more comprehensive evaluation and judgment can be made. Users can rotate, zoom earth model to view the data better.

By taking into account of the intuitive display, user can click the entire earth model's boundary area or the data point, the system will pop up a descriptive text making an explanation for the data point clicked.

3.5. ArcScene Technology

We use ArcScene technology to display three-dimensional terrain.

A triangulated irregular network (TIN) is a digital data structure used in a geographic information system (GIS) for the representation of a surface. A TIN is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates (X, Y, and Z) that are arranged in a network of no overlapping triangles.

A TIN comprises a triangular network of vertices, known as mass points, with associated coordinates in three dimensions connected by edges to form a triangular tessellation. Three-dimensional visualizations are readily created by rendering of the triangular facets. In regions where there is little variation in surface height, the points may be widely spaced whereas in areas of more intense variation in height the point density is increased.

The system is mainly due to the original data point discrete elevation data; therefore, we use the TIN as the basis of topographic data storage. From it, we create 3D topographic map. All of these can be handily created by ArcScence technology. The following picture, Fig.4, shows the sample of terrain display.

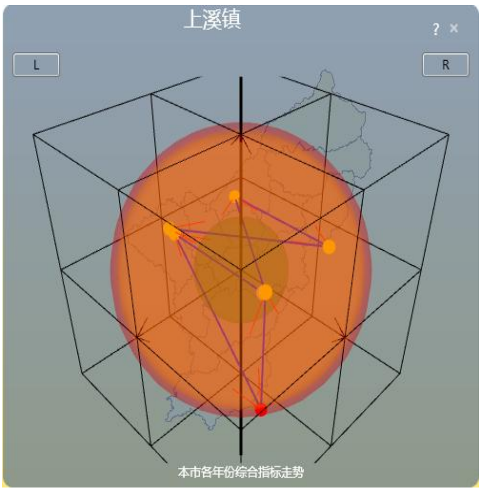

Fig. 3 3D earth model

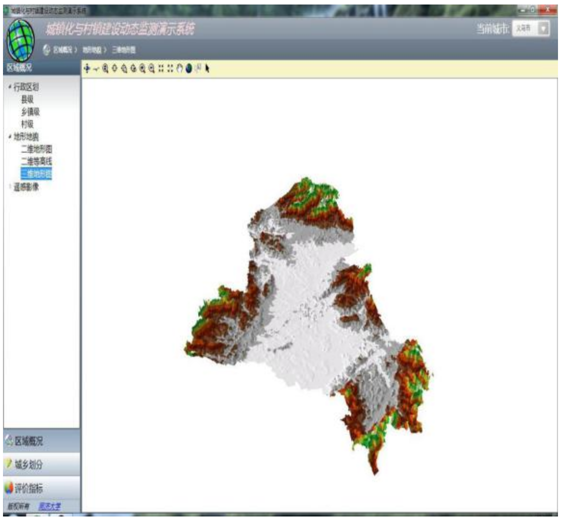

Fig. 4 3D topographic map

4. Conclusion

This paper describes the design and implementation of the Urban and Rural Development Monitoring System. The technologies used to develop the system are discussed as well. In order to assist users to perform data analyses and make decisions more efficiently, GIS technology is employed. GIS technology helps to integrating geo-spatial data in addition to regular attribute data. Furthermore, the system uses the WPF technology to display evaluation data for urban and rural development in three-dimensional mode for better understanding and visualization, which in turn facilitates the data analyses and decision making.

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6. References

[1] Ying Liu, "ArcGIS Engine Development and Application Reach", ISSN: 1672-8262.

[2] Nianjun Zhou, Liang-Jie Zhang, "An Analytic Architecture Assessment in SOA Solution Design and its Engineering Application", Web Services: 2009.

[3] Daoxun Xia, Xiaoyao Xie, Yang Xu;, "Web GIS server solutions using open-source software," Open-source Software for Scientific Computation, 2009 , Page(s): 135 – 138.

[4] Ediger, V. S., and Akar, S.., "ARIMA forecasting of primary energy demand by fuel in Turkey [J],"Energy Policy.2007 (35):1701-1708.

[5] Li-Hua Xiong, Feng Yang,"ArcSDE spatial database technology research," 2004.

[6] Chen Chen, Jian Li, Tang Zhang, "the research for the GIS component based on WPF", 2010.