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Research on Automatic Analysis Technology of Remote Sensing Monitoring Based on GIS

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ABSTRACT

GIS remote sensing technology provides a new generation of observation methods, description languages and thinking tools for scientific research, government management and social production. Therefore, we need to increase research and development of GIS. This paper proposes relevant methods, key points and problems to be solved through the combination of GIS remote sensing automation integration and integrated application. The remote sensing monitoring is the main data source and data updating method of GIS. The research further supports the comprehensive development and utilization of remote sensing information.

INTRODUCTION

Geographic Information System (GIS) is a new technology that began to develop in the mid-1960s. It was originally for solving geographical problems, but now it has become an interdisciplinary subject involving environmental science, surveying and mapping, computer technology, economic management, etc., collecting, storing, managing, describing and analysing the earth's surface and space and geography, distribution of related data information systems (Wegmann et al. 2017, Zhang et al. 2017). It is based on the geospatial database, with the support of computer hardware and software environment, collecting, managing, operating, analysing, simulating and displaying spatially related data, and adopting geographic model analysis method to provide multiple spaces and dynamics at the right time. Geographic information system, a type of computer application system established for geographic research, comprehensive evaluation, management, and quantitative analysis decision-making services. In short, GIS is a space-based data management system with computer graphics as a tool for geographic graphics and spatial location (Luo et al. 2017). It is a special and important management information system.

This paper reviews the remote integration monitoring automation integration technology of GIS, comprehensively summarizes, analyses and compares the relationship between geographic information system (GIS) and remote sensing (RS), and analyses geographic information system (GIS) and remote sensing (RS). The integration between the two illustrates that RS is the main data source and data update method of GIS. It also explains the application and development of GIS and further supports the comprehensive development and utilization of remote sensing information (An & Kumar 2017).

PAST RESEARCH

In 1963, Canadian surveyor Chen, L. first proposed the meaning of the term GIS and built the world's first Canadian Geographic Information System (CGIS) in three years and used it for Canadian land and resource management and planning (Chen et al. 2018a). Due to the low level of computer technology, small storage capacity and slow tape access speed, GIS had more machine-assisted graphics colours, and the geoscience analysis function was extremely simple. After the 1970s, the rapid development of computer hardware and software technology provided a powerful means for the input, storage, retrieval and output of spatial data, prompting the rapid development of GIS in the practical direction. Some countries have established many special land information systems and geographic information systems have played a major role in natural resource management and planning (Veronesi et al. 2017, Zhan et al. 2018, Yu et al. 2017). Canada, the former Federal Republic of Germany, Sweden and Japan had also developed their own GIS. At the same time, some commercial companies had become active and software was been welcomed in the market. During this period, many universities and research institutions began research on GIS software design and application. In the 1980s, the development of GIS system software and application software made GIS applications shift from solving infrastructure planning (such as roads and transmission lines) to more complex regional development and planning. For example, geographical factors such as agricultural use of land and urbanization had become an indispensable basis for investment decisions. Combined with satellite remote sensing technology, GIS began to be used for global problem research, such as global desertification, evaluation of global habitable areas, El Niño and acid rain, nuclear proliferation and nuclear waste, and global change and global monitoring (Olorunfemi et al. 2018). At the same time, the development of GIS software had also achieved great results, and some representative GIS software, such as Arc/Info, MrcoStation, MGE Intergraph, Auto CAD, etc., emerged. Since the 1990s, due to the smooth flow of information highways, the geographic information industry has been established, and GIS has gradually penetrated into all walks of life and even thousands of households (Chen 2018b).

GIS REMOTE SENSING MONITORING AUTOMATION RESEARCH

Remote sensing (RS) and geographic information systems (GIS) are the two major spatial technology tools that support modern geography. In recent years, their combination has attracted widespread attention and research. At the same time, as their application fields are from qualitative to quantitative, from static to dynamic, from the description of the status quo to the prediction, their integration has gradually evolved from the low-level to the advanced stage. Remote sensing is a science and technology that uses a sensor device to measure, analyse, and determine the nature of a target without directly contacting the research object. Some people refer to remote sensing as "distant perception." Remote sensing technology has the characteristics of macroscopic, real-time and dynamic in acquiring ground object information. Geographic Information System (GIS) is based on geographically oriented data, with the support of computer hardware and software, collecting, managing, operating, analysing, simulating and displaying spatially related data, and using geographic model analysis methods to provide timely and various directional and dynamic geographic information, a computer technology system built for geographic research and geographic decision making services. GIS and RS are two separate technical fields developed independently, but there is a close relationship between them (Boschetti et al. 2017). On the one hand, RS provides multi-temporal and multi-band information sources for GIS to make the information in the system current; on the other hand, RS provides geographic model analysis function for data management of GIS, providing tools for RS information extraction and geoscience analysis. The auxiliary data in GIS improves the classification accuracy and mapping accuracy of remote sensing information. Therefore, RS is the main data source and data update method of GIS. At the same time, the application and development of GIS further supports the comprehensive development and utilization of remote sensing information.

Automated integration: Integration means to form an organic whole by combining the dispersed parts. Formally, data integration is a logical or physical organic concentration of geospatial data of different origins, formats, and characteristics. Organic refers to the integration of data attributes, time and space characteristics, data itself and its expression in data integration. Remote sensing (RS) is a very important means or tool for spatial information acquisition. Geographic information system (GIS) is an important tool for managing information, analysing information and predicting the future. The close combination of the two is changing the human to the earth. With the deterioration of human living environment, the management of water resources has been increasingly valued by governments and scientists. The large-scale water environment not only costs a lot of money and huge manpower, but it can't be done. People have tried different methods of comprehensive analysis of data, using some geoscience data as auxiliary data, so that the accuracy of remote sensing applications greatly improved. With the development of GIS, it is recognized that although RS and GIS are relatively independent technical systems, the same objects of water quality research make them organically combined. In the GIS environment, the combination of multiple data including remote sensing signals can not only improve the accuracy of remote sensing information interpretation, but GIS will also benefit from remote sensing systems in terms of participating in system data analysis. In general, RS provides GIS basic data, which in turn serves RS. GIS can store, retrieve, calculate, and analyse these data, and at the same time provide assistance for remote sensing classification and correction. The integrated technical methods can include:

1. Remote sensing image correction: According to the relationship between the aspect and the remote sensing image, the digital correlation technology is used to automatically select the control points to perform geometric correction of the remote sensing image.
2. Composite display: The superimposed composite display of remote sensing and geographic information system can help users to quickly and accurately select the training sample area or directly edit the screen of the classification result.

3. Establishing a digital elevation model: The parallax model can directly generate a digital elevation model from a remote sensing stereo image, eliminating the heavy work of digitizing the terrain contours and avoiding the errors caused by ground elevation interpolation.
4. Automated or semi-automatic extraction of thematic information: With the support of the GIS, the thematic information is automatically extracted from the remote sensing image and the GIS database is updated.
5. Remote sensing image geographic information system operation: Calling the geographic information system image manipulation function to process remote sensing images, including digital transformation, statistical calculation and so on.
6. Remote sensing and geographic information system integration technology system: An integrated system integrating remote sensing processing and geographic information system functions.
7. Remote sensing image-assisted GIS spatial data acquisition and update: GIS spatial data acquisition and update requires remote sensing imagery for assistance (Shao et al. 2018).

Automated integration methods and applications: The combination of GIS and remote sensing images usually has the following three ways:

1. Using a software interface, this combination is economical and practical, and its essence is to solve the data conversion between the geographic information system and the remote sensing image processing system. In the specific implementation, some combined systems have been developed. There are two main methods: one is to use the geographic information system as a subsystem in the remote sensing technology system; the other is to extend the remote sensing image processing function in the geographic information system. Many systems currently use the latter approach.
2. Develop a standard spatial data exchange format as an intermediate format standard for the conversion between geographic information systems and remote sensing image processing, and between different types of geographic information systems (Yu et al. 2017).
3. The geographic information system and the remote sensing image processing system are combined to form a complete system. In this system, the two have become a unity, realizing a true combination. This requires the design of a more efficient data structure model and spatial data management system it can coordinate management of vector data and raster data and achieve comprehensive query and model analysis of spatial data.

ANALYSIS OF RESULTS

Automated integration analysis: RS and GIS are two mutually independent technical fields. With the continuous development of their application fields and their own continuous development, from qualitative to quantitative, from static to dynamic, from the status quo to the prediction, their combination has gradually evolved from a low-level to an advanced stage. The combination of RS and GIS can not only ensure the efficient and stable information source of geographic information system, but also real-time processing, scientific management and comprehensive analysis of remote sensing information to achieve the purpose of monitoring, forecasting and decision-making. Through the above analysis, the automation of GIS and RS mainly has the following aspects and advantages: (1) Remote sensing can obtain large-area regional data. (2) Remote sensing broadens the data hierarchy. (3) Remote sensing transfers field work to the laboratory. (4) Geographic information systems can make full use of remote sensing information. Geographic information systems use a variety of remote sensing data to establish mathematical analysis models of various natural elements, quantitatively study various natural condition factors or natural resources. (5) Mathematical models are the link between remote sensing and geographic information systems.

Automated integration approach and application analysis: According to the current research status, related automation can be divided into three categories which basically reflect the depth of the comprehensive application of the two and the level of analysis problems.

1. Level 1 combination method: This combination method is independent and parallel to each other. It exchanges data between two selected image analysis systems through a software interface. The first level combination method can simultaneously display GIS data (vector structure) and RS image (grid structure), and input the image processing result into GIS, and also input the result of GIS spatial analysis into image processing software. This combination is typically achieved by adding a data conversion interface between the existing GIS and image analysis system (see Fig. 1). This is an independent, parallel approach where the two software modes are only connected in data exchange.
2. Secondary combination mode: Two software modules share one user interface, and serial or parallel processing of raster-vector structure can be implemented. It should have the ability to directly perform image processing of GIS vector data, and unify the ability of different data input methods, error analysis and remote sensing data to simulate temporal changes (Fig. 2). This is a seamless mode where two software modules share a single user interface and can be displayed simultaneously.

Three-level combination: RS and GIS are used as a unified system to achieve a true combination of the two. The unified system will have the coordination of raster and vector data in the layer structure, the combination with the so-called measurement information system, allowing for comprehensive spatial query, generating a comprehensive model of real-world entities and determining corresponding models based on the model (see Fig. 3). This is a unified way to achieve a true combination of the two and is a long-term goal.

Current priorities and issues: At present, the integration of RS and GIS can focus on the following aspects:

(1) The implementation of RS and GIS integration.

(2) GIS (vector) data is displayed simultaneously with remote sensing image (raster) data.

(3) Incorporate low-level image processing results into GIS.

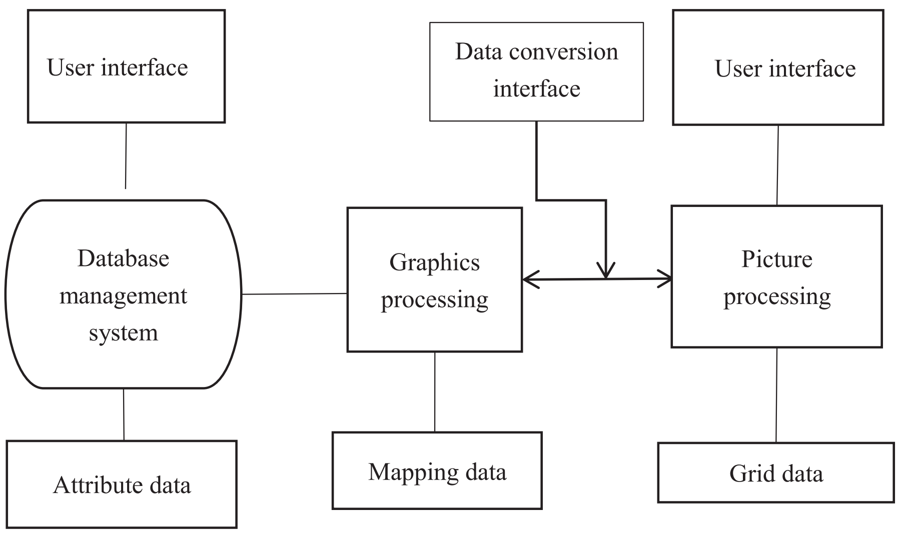

Fig. 1: Level 1 combination.

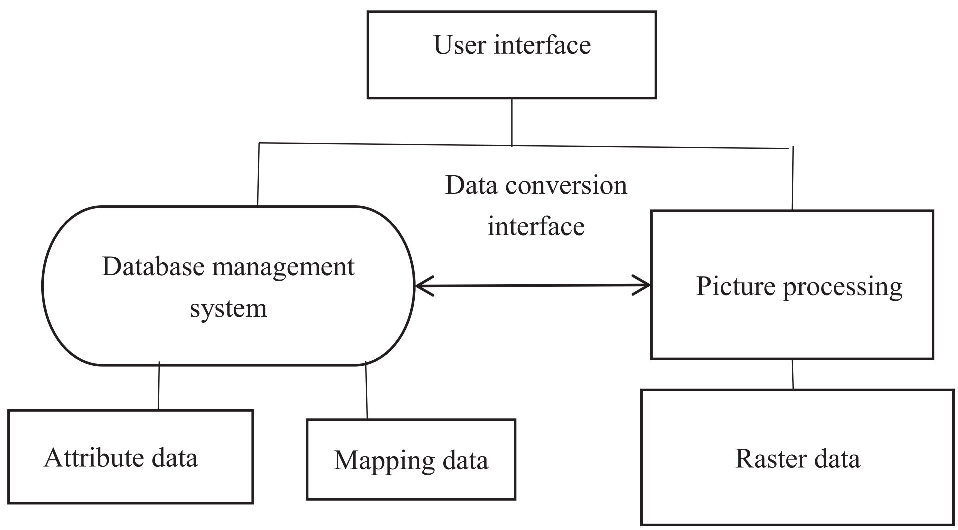

Fig. 2: Two-level combination.

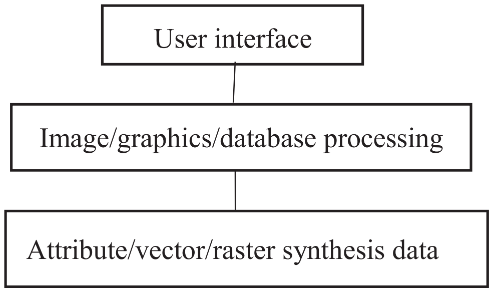

Fig. 3: Three-level combination.

(4) The result of combining the image with the vector data is incorporated into the GIS.

(5) The results of GIS spatial analysis are incorporated into the image processing and analysis process to play the role of GIS in decision-making.

Specific issues:

The spatial registration of remote sensing images and GIS data for joint analysis and processing of RS, high-precision geometric registration is particularly important. If the registration accuracy is poor, errors will be generated in the analysis, which will seriously affect the classification result.

1. Errors in GIS spatial data: For various reasons, GIS data may have errors, such as lack of detailed initial investigations, causing errors in position and attributes; errors caused by unreasonable interpolation; and merging unidentified units into larger units and boundary mapping or digitization processes small errors, etc. In particular, the error caused by the difference in phase between GIS data and remote sensing data. When using these GIS data for remote sensing image interpretation, it will inevitably lead to error transmission. However, people still don't know much about the whole mechanism of this error transmission which needs further study.
2. Extraction of remote sensing interpretation information in GIS data: The key to integrating GIS in remote sensing interpretation is how to extract effective information and patterns from GIS spatial data, and automatically integrate into the interpretation of remote sensing images. However, due to the complexity of geospatial data, variability and remote sensing purposes are diverse, and the mechanism of remote sensing is not fully understood. Therefore, the technology for extracting useful information from remote sensing of GIS data is still limited, and there is still a lack of automatic implementation of common tools. Currently, research on data mining is expected to achieve this goal.

CONCLUSION

This paper reviews the automation integration technology based on GIS remote sensing monitoring, and comprehensively summarizes, analyses and compares the relationship between geographic information system (GIS) and remote sensing (RS). Through the introduction and research of related automation technology, the research on automation integration, methods and applications of related integration, it is concluded that RS is the main data source and data update method of GIS. At the same time, this paper studies some related technologies and also finds some existing key points and problems, which provides a good direction for subsequent research, but also raises the problem for us to solve in future research, so that based on remote sensing monitoring of GIS better serves human production and life. In the near future, this technology will certainly be used in more fields and directions.

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