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Explorations of GIS application in digital landscape management systems

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ABSTRACT

As an outcome of the information technology advancement, our economy and life have been greatly changed, and the concept of "Digital Earth" has spread to all corners of the world. The digital information model, based on computer technology, multimedia technology and storage technology, has cultivated a brand-new concept of digitization for the mankind wit its mass geographic information, multi-scale and multi-angle graphic mode. To improve forest administration, this paper studies GIS applications in digital landscape management systems combined with actual situations, notes that this technique is of great significance to the digital landscape information management, builds a digital landscape management system platform based on GIS, gives full play to GIS in digital landscape management systems with availability and reliability satisfied, and provides assistance to the landscape planning and management.

KEYWORDS

GIS; Digital landscape; Management system.

INTRODUCTION

During forestry development, the strategy of "forestation through science and education" puts forward higher requirements on the construction of "digital landscape". On one hand, 3S technology should be made full use of, so as to perform unified digital reproduction and understanding of landscape-related resources and phenomena, utilize forestry information resources to the maximum extent, and focus on studying forestry resource monitoring technology, combined with forecasting technique of geographic information systems, pest warning technology, disaster management information system, decision-making support system, network management technology and so on. On the other hand, GIS-based software should be developed, so as to cater to needs of landscape information management and sharing services, and lay a basis for the construction of "digital landscape" in terms of technology, software and application.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

The concept of GIS

Geographic Information System (GIS) is a comprehensive technology integrating computer science, geography, surveying, management science and statistics[1]. Since GIS involves a lot of factors, there is no exact definition. It may be defined distinctly when measured from different perspectives. In terms of functions, GIS is a system of geographic data collection, storage, inspection, operation, analysis and display. In terms of applications, GIS can be divided into various application systems, such as the land information system, tourism information management system, city information system, planning information system, etc. From the perspective of toolbox definitions, GIS is a tool aggregation of space data collection, storage, query, analysis and display, with an emphasis on geographic data processing tool. When it comes to database definitions, GIS database data is arranged in space order, and provides a data operation collection platform, used to respond to space entity query in the database.

As an integrated and interdisciplinary subject, GIS revolves around computer science with, database, map visualization and spatial analysis as basic techniques (Figure 1). Therefore, GIS can be defined as a computer technology system that processes geographic data, integrates input, output, management, edit, query, analysis, simulation, display and auxiliary decision-making, and serves geographic research and decision-making[2].

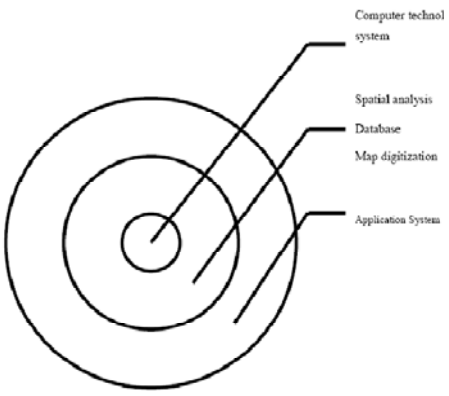

Figure 1 : GIS core and technology composition

Composition of GIS

GIS consists of data input subsystem, graphic and text editing subsystem, space query and analysis subsystem, and data output subsystem. The relationship between various subsystems is shown in Figure 2.

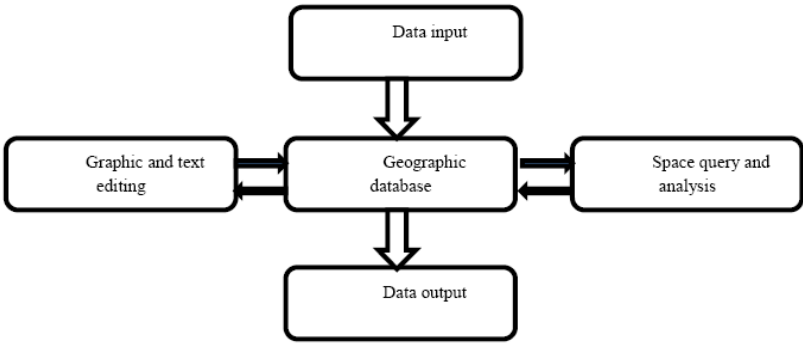

Figure 2 : Basis system composition of GIS

Functions of GIS

Main functions of GIS include access to spatial distribution, query, retrieval and online processing of geographic data, as well as resources sharing on the Internet, as shown in TABLE 1. The basic function realization process is shown in Figure 3[3-6]. The purpose of data edit, transformation and processing after data acquisition is to ensure the integrity and logic consistency at the time of data storage. When it comes to data edit, processing and error correction, distinct methods need to be adopted as per various demands. For instance, vector to raster conversion may be used for data format conversion; translation, rotation, scaling, correction and other methods may be used for data proportion conversion; projection may be used for data transformation; smoothing and function aggregation may be used for data generalization; geometry transformation (stitching, interception, compression, structure) may be used for data reconstruction; topology may be used for geocoding. Data structure determines the GIS data analysis capabilities, efficiency and accuracy, mainly including the vector structure, raster structure and raster/vector structure. Data output is mainly performed through data exchange in forms of statistical tables and graphics (thematic maps, image maps, statistical maps and topographic maps).

TABLE 1 : Main functions of GIS

Function	Content
Access to spatial distribution (query and analysis) of geographic data	GIS may obtain various geographic data across the globe under Internet WEB through technical means. For instance, it may transform the already existing graphic data into GIS base data via digitization, which can facilitate data sharing and transfer.
Spatial query, retrieval and online processing of geographic data	WEB browser is used in terms of its interaction capabilities to enable query and retrieval of graphic (visualization) and attribute data of GIS, and data processing among clients from various regions.
Analysis of space models	Various analysis methods of application models are made available on high-performance server sides. By receiving model parameters provided by users, calculation results are returned to GIS clients via graphics or texts after rapid calculation and analysis.
Resources sharing on the Internet	GIS may organize and manage information resources with mass spatial distribution on the WEB internet, provide various information services based on spatial distribution to users, improve resource utilization rate and level of sharing.

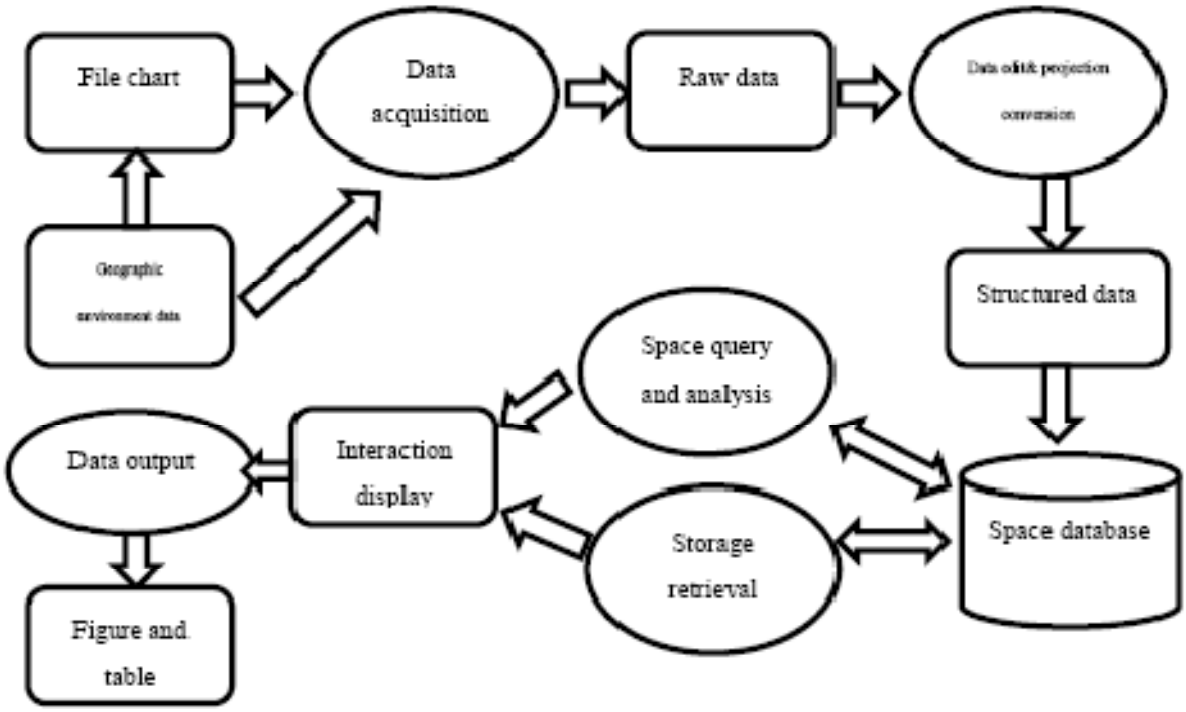

Figure 3 : Basic function realization process of GIS

BRIEF INTRODUCTION TO THE DIGITAL LANDSCAPE MANAGEMENT SYSTEM

In the context of China's comprehensively promoting the rapid development of urban landscape greening and urban landscape construction, it has been a common goal for many cities to "further strengthen environmental protection and

greening, improve the urban ecological environment, emphasize equally both pollution control and ecological construction, and adhere to sustainable development"[7]. Traditional management methods fail to perform accurate statistics to community greening, such as ancient trees, parks, scenic spots and other information. With increased quantity and density of urban greening, the complexity grows. Coupled with vigorous greening construction and renovation in urban areas, various greening information and related engineering data are mostly stored in paper form, with a lot of incomplete and inaccurate information. Compared with modern management methods, traditional manual management methods are backward and inefficient, with a low level of information. Difficulties in data reality, management dynamic, extensive applications, and detailed content and so on have posed serious obstacles for smooth landscape management. From the source, landscape data is decentralized and independent, with a lack of reality. With the existing technical means, landscape construction spatial information is relatively closed and unable to be provided to the general public. Information services can only be provided relying on advanced spatial information technologies, such as GIS. As a result, urban landscape planning and design, construction, green space management, parks, ancient trees can help make possible the grid-based, fine, standard and routine landscape management.

GIS application targets in digital landscape management system

In order to reach system requirements from landscape management departments, GIS technology is applied in "Digital Landscape" management system in the field of landscape greening, providing a complete set of functions including space data access and processing, database integration and management, analysis and application. Computers are used for classified browse, query, statistics, information management and administration approval for urban landscape, working as an auxiliary tool for macro decision-making and business implementation of landscape management departments.

GIS application principles in digital landscape management system

To reflect that the digital landscape management system is comprehensive, integrated and long-term, GIS application in the digital landscape management system must be based on overall design and demonstration of "Digital Landscape" system, with science going through it, so as to achieve a scientific, rational, advanced, economical and practical type selection and configuration of software and hardware, to meet user needs for spatial data and statistical data, and optimize the "Digital landscape" management system.

GIS application in the digital landscape management system should follow the following principles: (1) standardization. The GIS application in the digital landscape management system should follow and implement unified national standards and norms. During the construction of the "Digital Landscape" management system, a unified graphic information classification coding and attribute information indicator system, system development technical specification and standard should be put in place, establishing a standard business model for landscape management departments. (2) progressiveness and openness. GIS application in the digital landscape management system should adopt advanced production technologies, building programs, database technologies and network technologies, and try to be based on GIS platform and hardware devices with a strong scalability, high efficiency, and easy development and maintenance. In the design of the "digital landscape" management system, business requirements of landscape departments should be considered first; during the construction process, its integrity, openness and scalability should all be taken into account. (3) accessibility. The GIS application in the digital landscape system management should fully reflect user-oriented ideas, and proceed from different levels and angles, so as to make the interface more intuitive, convenient and friendly, provide a comprehensive, real and dynamic technical support, and offer complete online assistance.

GIS APPLICATION IN THE DIGITAL LANDSCAPE MANAGEMENT SYSTEM

GIS application in the digital landscape management system should integrate spatial database for landscape greening and integrated application data for infrastructure, so as to fully understand the status quo and planning information of the regional and greening construction, provide real-time monitor to landscaping, and offer useful landscaping information for designating regional strategies.

Module process for the digital landscape management system

The digital landscape management system with GIS technology is a system module that is combined with landscape business management processes and integrates design, office and approval business processing, and can improve the efficiency of landscaping approval. The landscaping data statistic function may cut a lot of workload in statistics, verification and computation, integrate information system with routine landscape business, and promote e-government work to be convenient and efficient. The module flowchart for the digital landscape management system is shown in Figure 4[8-9]

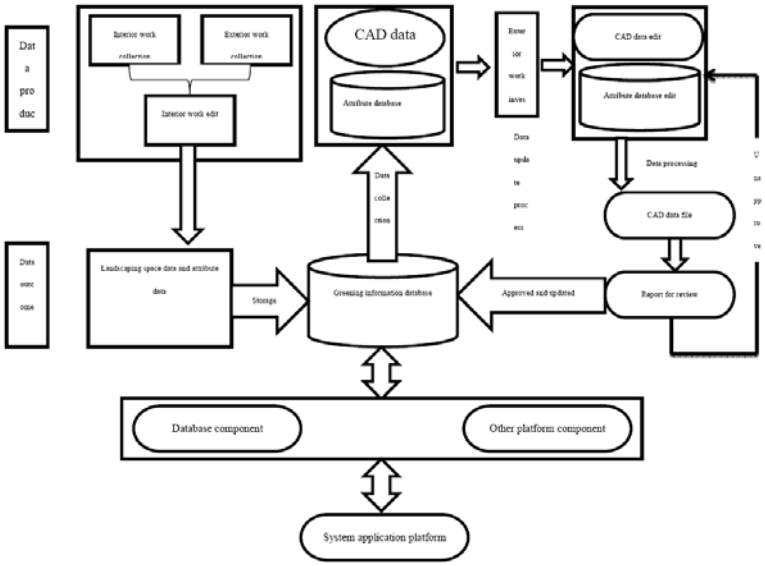

Figure 4 : Module flowchart for digital landscape management system

The digital landscape system is quite complicated. To achiever internal standardization and unity, and a smooth convergence between the system with GIS and other systems, the system standardization should be conducted prior to the system construction, which should be performed in accordance with relevant national standards, industry standards and local standards, combined with actual situations of the landscape system, system goals and user needs, so as to develop standardized system construction standards. For more details, see TABLE 2.

TABLE 2 : Data standardization system for digital landscape

1. Geographic positioning control standard	6. Spatial positioning statistic unit
2. Classification and coding system for graphic data	7. Data acquisition, database technology flow, quality control
3. Attribute data indicator system	8. Metadata standard
4. Data stratification scheme	9. Schematic symbol system in line with national standards
5. Data file naming rules	10. Unified, standardized system database directory

Data collection

Interior and exterior mapping work production involved in digital landscape projects need to keep pace with software R&D in a real-time manner. With complex processes, sub-design is a must. The entire process can be divided into 7 stages, separately data preparation, interior work collection, interior work edit, exterior work investigation, supervision inspection, data processing and storage, submission for test run. Each stage is conducted by specific departments in charge, so as to keep the collected data accurate. The specific process is shown in Figure 5[10-11].

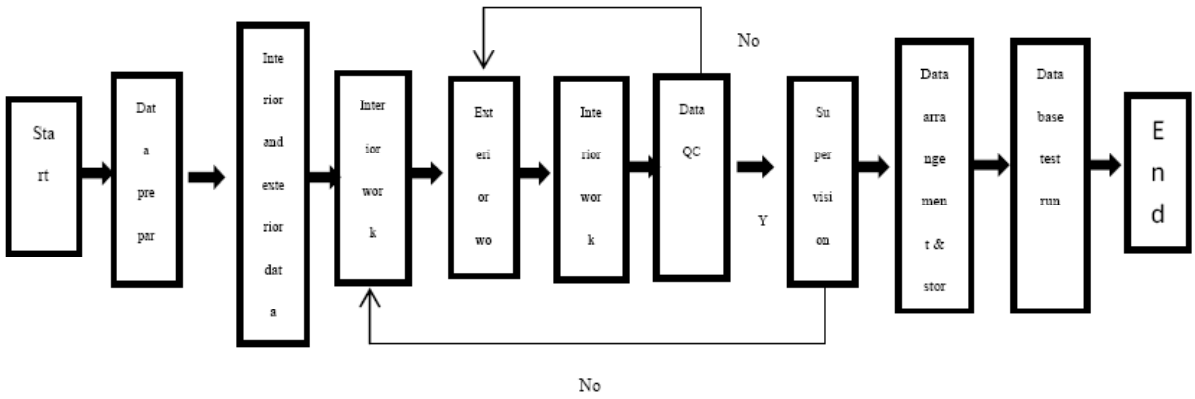

Figure 5 : Data collection process

System database establishment and application platform

Digital landscape management system that uses GIS technology requires supervision over result data and format conversion to input greening information database and meet customer needs, so as to allow its subsystems to complete greening information database construction. Application platforms for GIS digital landscape management systems mainly include the two subsystems of digital landscape database establishment and management, for the sake of unified management to spatial data, so as to achieve landscape data processing, storage, update, query, browse, metadata management, application distribution and so on, integrating the functions of basic data processing, query statistics, data display, data extraction, data integration, rights management, database management, and spatial analysis, specifically shown in Figure 6. Based on routine work of gardening departments, the platform is combined with greening design, construction and implementation processes, extracts real-time green space data from the greening database, performs data edit and modification, reports management departments for approval, stores and updates the approved green space data in the database, so as to keep consistency between data in the greening database and the real green space conditions.

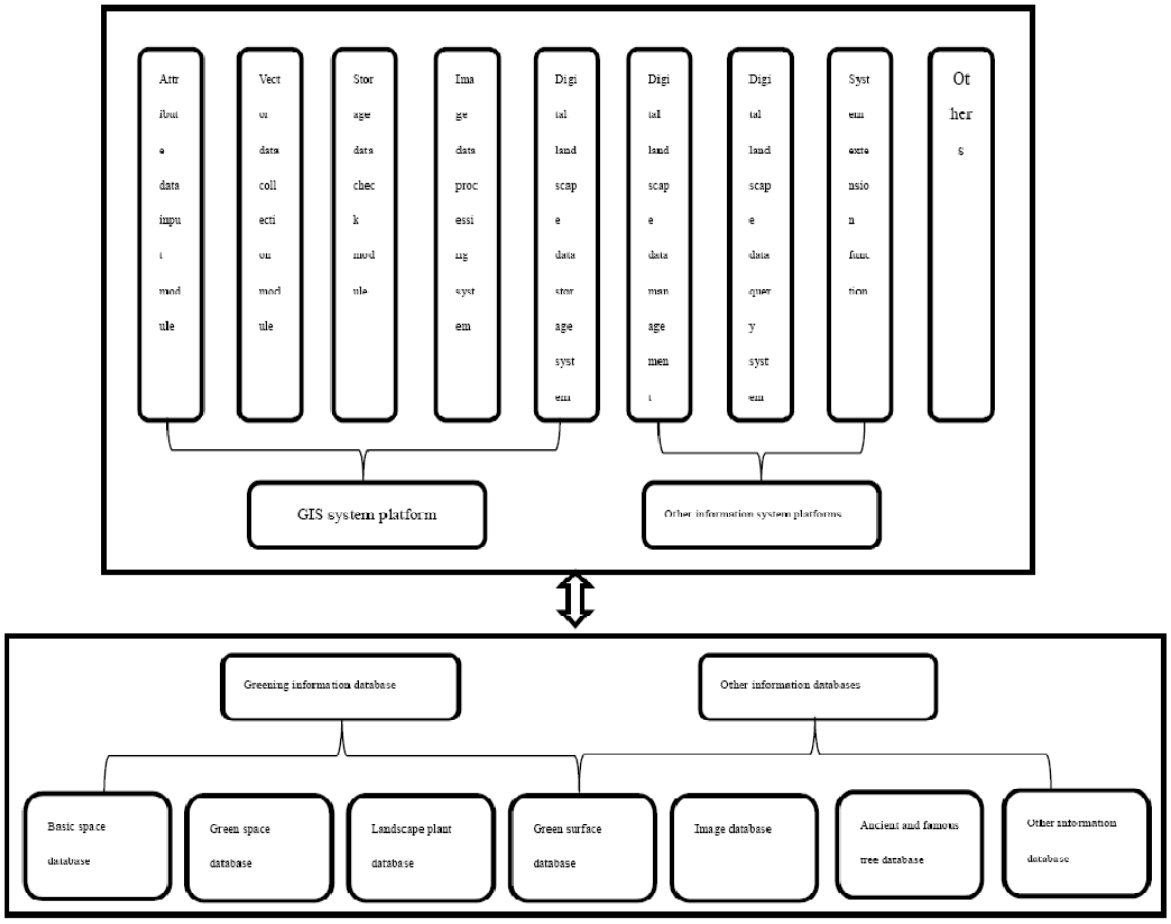

Figure 6 : Application platform for GIS digital landscape management system

CONCLUSION

GIS digital landscape management system enables the storage of basic terrain data, thematic spatial data of greening, image data, greening information, etc., with computer technology as the core, and achieves functions of input, edit, storage, query, display, analysis and auxiliary decision-making of spatial information and attribute information of various green space and trees. The application of GIS technology in digital landscape management systems is favorable to digital landscape information management, resource sharing and integration; helps improve the decision-making level and efficiency of digital landscape management; makes forestry administration more convenient and efficient management, with practical significance to digital landscape management.

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