DEVELOPMENT OF 3D GIS MODELING TECHNOLOGY

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Abstract: Recent researches on Three-dimensional Geographic Information System (3D GIS) modeling technology were reviewed. The concept of 3D GIS modeling and its application in various fields were introduced. Essential techniques to realize 3D visualization were studied. A typical 3D GIS modeling usually contains the description and the transmission of GIS spatial data structure. GIS spatial data models were described and species of 3D GIS models were summarized. Current algorithms for transmitting data to 3D models were compared and analyzed.

Keywords: 3D GIS modeling, visualization, review, 3D models.

1. INTRODUCTION

Three-dimensional Geographic Information System (3D GIS) modeling technology can provide a more lively and intuitive visual angle. It has been used in many different fields including military affaires, mining, geology, oil exploration and medicine etc. 3D GIS model is a spatial data model, which provides basic information for describing GIS spatial data structure and designing spatial database. It reflects the correlation of spatial entities in the real world. At the same time, it is a theoretical basis for spatial data processing and spatial data mining (Chen Lichao et al., 2004).

In 2002, Shinji Araya et al. proposed a flexible and efficient VRML-based terrain model. It can simplify the changes of display range and attach an automatic changeover by placing the given terrain models (tiles) in 3D space (Shinji Araya et al., 2002). In 2003, Elizabeth Burson presented two methods of 3D GIS modeling for professionals to incorporate models such as buildings, caves, viewsheds and many man-made objects into their greater GIS environment (Elizabeth Burson, 2003). Zhang Jing et al. discussed the 3D GIS modeling technology in urban GIS by combining the traditional GIS and virtual reality. Exact information and useful methods for promoting scientific urban management were provided (Zhang Jing et al., 2003). T. H. Kolbe et al. proposed a unified model to represent spatial objects in 3D city and regional models, which describes the real world objects by geometric, topological and thematic properties (Kolbe T.H. et al., 2003). Zhu Qing et al. introduced 3D GIS for the digital documentation of a special T'ang-wooden buildings based on personal computer. They firstly applied 3D GIS modeling technology in digital cultural heritage (Zhu Qing, 2006).

Maps are useful tools to cognize spatial information. In the traditional plat maps, symbols are used to represent spatial objects. As the development of computer techniques and 3D techniques, traditional 2D static plat maps are developed to 3D dynamic virtual environments (Zhu Qing et al., 2003). Based on spatial database, 3D GIS modeling technology adopts Virtual Reality (VR) technique to construct virtual environment. The application of 3D models is accelerated by the development of 3D visualization of spatial information. As Wei Yongjun put forward, 3D models have all the characters and basic functions of the plat maps (Wei Yongjun, 2000). According to the researches on 3D GIS modeling technology, it mainly contains the description and the transmission of GIS spatial data structure.

2. DESCRIPTION OF GIS SPATIAL DATA STRUCTURE

2.1 GIS spatial data models

GIS spatial data models are composed of three basic hierarchies including conceptual data model, logical data model and physical data model. Conceptual data model is an abstract of the relationship between entities. Logical data model is used to express the data in conceptual data model and the correlation between them. Physical data model describes the physical form, storage, path and database structure of data in computer. The spatial data models are expressed by grid model and vector model. Vector model is entity-oriented and considers specific spatial objects as the described objects.

Grid model is space-oriented and regards geographical space as an integer for describing. Usually, grid model is mainly used in digital terrain analysis.

2.2 Species of 3D models

To classify 3D models is a cognitive course to analyze and define spatial objects (Ranzinger M et al., 1997). According to the efficiency of 3D visualizing expression, 3D models can be classified to three species: (1) has inflexible geometry shape and similar external texture. It also has important characteristics in figure and position. A realistic 3D model can be used repeatedly, such as the model of street lamp. (2) has random geometry shape and similar external texture, which also has important characteristics in figure and position. The texture images used to express these objects include tree, flower and grass etc. (3) has random geometry shape and external texture. One can simulate these objects with a given random function, for example, fountain, waterfall, rainwater, surf and fireworks etc.

3. DATA TRANSMISSION OF 3D MODELS

3.1 3D GIS Visualization based on 2.5D GIS

The 2.5D GIS visualizing method is often adopted to realize 3D visualization. It mainly uses high quality Digital Elevation Models (DEM) and high reality 3D vision technology (Wu Xincai, 2002). The 3D visualization is greatly impacted by the quality of DEM which depends on the algorithm for realizing it. Therefore, it's important to select a convenient algorithm with strong practicability, high precision and quick reaction speed. Considering the complex relationship between the points, lines and polygons in the algorithm for creating Triangulated Irregular Network (TIN), a special data structure was adopted to build a preferable topology relationship. In addition, fast index can be established between the points and sides of TIN and triangles, which facilitate the design of the algorithm.

3.2 Euclidean distance converting model and algorithm

Distance calculation is a common algorithm to process spatial data. Euclidean distance converting algorithm is propitious to grid data. Proved by experiments, it is an effective algorithm to calculate distance with its high speed, adjustable precision and simple program. The algorithm is composed of distance conversion and converting algorithm. In grid models, spatial objects are divided into four species including points, lines, polygons and

bodies. For any kind of grid data, the position, shape and topological information of objects can be described clearly by using Euclidean distance converting algorithm (Chen Lichao, 2004).

4. CONCLUSIONS

The recent researches on 3D GIS modeling technology were reviewed. The 3D GIS modeling technology was developed rapidly and applied in many different fields. In recent years, the development of computer techniques and visualizing technologies brought promising advances to 3D GIS modeling technology.

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