RESEARCH ON METHOD FOR 3D URBAN GEOLOGICAL MODELING

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Abstract: With the rapid development of urban area in china, the geological problems are becoming outstanding day by day. 3D geological modeling not only can precisely describe the 3D spatial information underground, but also provide a decision background for urban resource analysis, underground engineering planning, disaster prevention and mitigation, it has been an important research issue of 3D GIS. Based on the analysis of previous researches on 3D geological modeling, and with all kinds of exploring borehole and section as main data source be considered, three key problems of 3D urban geological modeling are studied as follows:

1) The processing and organization of borehole data. Because of different kinds of exploring methods and aims, the format of borehole data is different. Meanwhile, the acquirement of borehole data is very expensive, which make the sample ratio is very low. In order to construct precise 3D geological model, some interpolation methods, such as Natural Neighbor Interpolation (NNI), inverse distance weighted interpolation and Kriging interpolation, must be used. According to the borehole interpolation requirement and the characteristic of 3D geological modeling process, NNI method based on the voronoi diagram of borehole collar data is discussed. The concept of virtual borehole is put forward, which could be classified into half-virtual borehole and full-virtual borehole, and the related interpolation methods are studied. In consideration of the requirements of data management and 3D geological modeling, borehole data is organized as statistic data, strata data and deflection data.

2) The construction method of 3D urban geological model. The Generalized Tri-Prism (GTP) model, which is an universal form of Tri-Prism (TP), Pyramid and TEN, is used to construct 3D geological model. The constructing process includes two steps, the first is to generate the Delaunay TIN (D-TIN) of terrain according to borehole's collar data, which is the foundation of constructing a 3D geological model; the second is to extend each triangle of the TINs along the borehole line. Two kinds of constructing algorithm for D-TIN, respectively be constraint D-TIN (CD-TIN) and no constraint D-TIN, are discussed. The Dynamic Including Triangle (DIT) method is introduced to solve the expansion of borehole collar point sets, and an improved repeating diagonal exchange algorithm for the compulsively inserting of constraint edge is applied to solve the characteristic line constraint of terrain. A 3D modeling inference rule is proposed to solve the automatic constructing problems of 3D geological model. In consideration of the strata code of borehole, this rule decides the mode of the extension of a triangle into a GTP by judging the number of triangle's vertex, which can solve the constructing problems of complex geological structure, such as bifurcation, pinch-out and fault.

3) The application of 3D urban geological model. It includes three parts: a) 3D interactive visualization, b) interactive inquiry, c) aided design. The aim of 3D interactive visualization is to analyze and to mine the inner information of 3D geological model by the 3D interactive technique. An auxiliary segment sliding bar (ASSB) method, which is the key issue of 3D interactive technique, is put forward to select any arbitrary point in 3D geological model. Based on the 3D interactive technique, the realizing methods of 3D geometric transform, arbitrary interactive cutting, virtual exploring and other 3D visual operation, are discussed. Interactive inquiry includes point position inquiry, distance inquiry, volume inquiry, attribute and graph inquiry, spatial relationship inquiry and so on. The related realizing methods are discussed. Aided design is an important part of the application of 3D geological model. Based on the constructed 3D urban geological model, the method for subway design is introduced. Some techniques including the 3D integral visualization of subway and strata, the excavation and quantity calculation on subway, the relationship analysis on subway and strata spatial, are introduced.

A real-3D geosciences modeling system, GeoMo3D, developed with VC++, OpenGL and SQL sever, demonstrates the results of 3D urban geological modeling and its application. An actual 3D geological model of an exploring district of the Central Business District (CBD), downtown Beijing, is shown as a case.

KEY WORDS: 3D urban geological modeling; digital city; generalized tri-prism (GTP) model; 3D interactive visualization; aided design