Abstract

The growth of cities has complicated the tasks of urban planners and managers to such an extent that new solutions are needed for maintenance and analysis of data. The most challenging issue, i.e. the handling of 3D geo-information, has been investigated for years and has resulted in various concepts and software developments. The work reported, however, reveals little evidence of the integration of concepts on 3D data structuring to enable spatial analysis and ensure fast 3D visualisation.

The goal of this research is the definition of a conceptual model that is capable of handling the variety of objects of interest for urban planners in a way appropriate to analysis and interactive 3D visualisation employing current technology developments. Bearing in mind the increasing publicity surrounding planning and management activities, the research concentrates on a web-oriented approach to access and 3D visualisation. To achieve this goal, the research strategy followed is: 1) investigating and classifying objects of interest, 2) specifying a web oriented system architecture for query, retrieval and 3D visualisation, 3) defining a 3D GIS model and 4) implementing and testing.

An investigation into user requirements for 3D GIS is completed on the basis of information currently maintained in a representative municipality and the interview of producers of urban data. A system architecture for web query and 3D visualisation based on a DBMS, a Web server, Web browsers and VR browsers is suggested and implemented. The client-server communication relies on CGI scripts. VRML and HTML are employed to develop a front-end user interface. An extended definition of an object is presented in order to handle objects, their characteristics, behaviour and 3D topological relationships.

Considering user and visualisation requirements, a 3D topological model called the Simplified Spatial Model is formally defined using set theory notions. The model maintains the four geometric abstractions of a real object, i.e. point, line, surface and body, which are formed by two constructive objects, i.e. node and face. The spatial model (holding information about geometric description and spatial relationships) and two spatial object's components (geometric attributes and geometric behaviour) are organised in a Simplified Spatial Schema and implemented in an RDBMS. Links to existent data collection procedures are explored and adapted to provide data for functional tests.

The capacity of the model to derive 3D topological relations is proven by an elaborated investigation on the basis of the intersections between boundary, interior and exterior of an object. The suitability of the model for web query and 3D visualisation is proven by tests on representative spatial queries executed on a prototype system. The flexibility of the user interface suggested is demonstrated by a number of examples.

The theoretical and experimental work carried out accomplishes the goal of the research: a 3D GIS model is defined to maintain data about thematic and geometric characteristics, behaviour and relationships (3D topology) between objects, ensuring quick realistic 3D visualisation. Moreover, the results of the research contribute to: 1) the clarification of the possible 3D topological relations between spatial objects, 2) the query and visualisation of 3D spatial data over the Web and 3) the creation of realistic 3D models.

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