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Editorial
Geovisualization: Design, Enhanced Visual Tools and Applications

With rapid development of geospatial information technology and its convergence to the advances in laser scanning and location-aware computing, it is projected the volume of geospatial information increases by several orders of magnitude over the next decade (NRC 2003). Under the circumstances, how to effectively and efficiently analyse and use the information for various decision-making processes has long been a pressing challenge for geospatial information scientists. Spatial statistics, analytical models and various other kinds of reasoning models surely help a lot in this respect. On the other hand, visualization provides an important means to handle the information for knowledge discovery processes. It augments human visual ability in perceiving high complex structures, and in detecting, exploring and exploiting salient patterns.

Rooted in traditional cartography, geovisualization refers particularly to the visualization of geospatial information and it integrates knowledge and expertise from various related fields such as scientific visualization (McCormick *et al.*, 1987), information visualization (Card *et al.*, 1999) and virtual environments. Geovisualization on the other hand contributes significantly to other visualization fields. For instance, the map metaphor has been widely used to visualize non-geographic information in the domains of information visualization and domain knowledge visualization.

There have been steadily growing research interests and efforts in the cartographic and geographic information science community for effective and efficient visualization of geospatial data using a variety of new technologies for the purposes of geographic knowledge discovery and decision-making processes. Geovisualization serves two important functions, namely communication and analysis (Jiang, 1996). To usefully coordinate research efforts, the international cartographic association commission on visualization and virtual environments have organized a series of workshops and publications focusing on the topic. A very recent special issue of the journal *Cartography and Geography Information Science* (McEachren and Kraak, 2001) identified some pressing research challenges for geovisualization involving representation, linkage to knowledge discovery and geocomputation, interface design, and cognitive and usability issues. Geovisualization continues to be an emerging research issue in the research agenda of geographic information science (UCGIS, 2004), and as such it is a featured theme in various GIS conferences and journals.

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OVERVIEW OF CONTRIBUTIONS

Presented in the special issue is a set of papers on geovisualization. Five of them were selected from the conference presentations with Geoinformatics 2004 (http://www.hig.se/geoinformatics/), and two were solicited separately. All the papers were expanded significantly and subsequently reviewed by at least two referees for each. The papers that follow present a diverse scope of geovisualzation ranging from design, copyright, enhanced tools and applications in environmental studies.

The first three papers deal with the design issue respectively from egocentric, wayfinding and copyright perspectives. One of the challenges for geovisualization is with the context of pervasive geographic information services to provide personalized visualization to diverse users. Liqiu Meng addresses the importance and necessity of egocentric geovisualization, in contrast to the traditional geocentric map design, for the purpose of promoting personalized services. The author defines ego centre in a comprehensive way, and suggests the approaches of detecting ego centres for the purpose of egocentric design. The work promotes more user-centred geovisualization. Itzhak Omer and his colleagues suggest, based on the experiments carried out, some design principles of virtual cities from the wayfinding perspective. Lynch's image of the city is the major inspiration source for the experiments and design. Details of experiment are reported. The work contributes significantly to the usability and cognitive issues of geovisualization. The next paper by Juergen Doellner focuses on embedding digital rights into 3D virtual environments to cope with privacy, security and copyright issues for the dissemination of geographic data. This work presents a key concept of geo documents that is a general framework, based on the object-oriented and graphics-oriented representations, for representing geo data from various sources. A digital rights management component is integrated with the representations and thus digital rights can be easily and flexibly handled via an interface.

The following two papers concentrate on the enhanced visual tools for knowledge discovery with geospatial information. Geovisualization can be well integrated with analytical methods and models for the purpose of spatial analysis, modeling and mining processes. David Kao and his colleagues present a series of visualization tools for exploring LIDAR datasets for the purpose of structure discovery and pattern recognitions. The authors demonstrate a paradigm shift from pure statistical analysis to visually enhanced representations of forest structures. Along the same line of developing visual tools for data exploration, Gennady Andrienko and Natalia Andrienko present a technique by modified parallel coordinate plots for the visualization of large datasets. It overcomes the shortcoming of the traditional techniques that rely on data selection and aggregation for exploratory analysis. The modified parallel coordinate plots can be used for exploratory analysis of large datasets at different levels more efficiently and effectively.

The last two papers can be characterized as application oriented. The paper by Jose Danado and his colleagues presents a multi-use mobile system for the visualization of environmental processes with personal digital assistants. With the system the users can be involved in monitoring and exploring complex environmental processes. This system is based on a server-client structure and involved with different hardware and software platforms. Finally, Jinxun Liu and his colleagues developed a windows utility (in contrast to existing Unix based ones) namely NCWin for handling NetCDF data, for modeling and visualizing large volume atmospheric and environmental datasets. It provides three basic functions of data conversion, processing and visualization by the use of component object model technology. Such a utility is of particular value for environmental visualization, which is often involved with large volume datasets.

CHALLENGES AND OPPORTUNITIES

The increasing demands for effective and efficient visualization of geospatial information to serve the general public over mobile contexts pose a pressing challenge. In this connection, geovisualization is closely connected to generalization, another important issue in cartography and geospatial information science. At another more advanced level, geovisualization should be well integrated with the emerging data mining and knowledge discovery field. This is for the professional users who are keen to use geovisualization tools for knowledge discovery and decision-making processes. We would like to see in the near future the increasing interplay and communication among geovisualization, scientific visualization, information visualization and the emerging domain knowledge visualization (Chen 2003). Currently topological based visualization appears to be an appealing approach to uncovering hidden structures and patterns of large geospatial datasets.

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