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Abstract
In economy, society and personal life map-based interactive geospatial visualization becomes a natural element of a growing number of applications and systems. The visualization of 3D geospatial information, however, raises the question how to represent the information in an effective way. Considerable research has been done in technology-driven directions in the fields of cartography and computer graphics (e.g., design principles, visualization techniques). Here, non-photorealistic rendering (NPR) represents a promising visualization category – situated between both fields – that offers a large number of degrees for the cartography-oriented visual design of complex 2D and 3D geospatial information for a given application context. Still today, however, specifications and techniques for mapping cartographic design principles to the state-of-the-art rendering pipeline of 3D computer graphics remain to be explored. This paper revisits cartographic design principles for 3D geospatial visualization and introduces an extended 3D semiotic model that complies with the general, interactive visualization pipeline. Based on this model, we propose NPR techniques to interactively synthesize cartographic renditions of basic feature types, such as terrain, water, and buildings. In particular, it includes a novel iconification concept to seamlessly interpolate between photorealistic and cartographic representations of 3D landmarks. Our work concludes with a discussion of open challenges in this field of research, including topics, such as user interaction and evaluation.

Abstract
Participatory mapping is an emerging practice in the community development discourse. With its roots in the Participatory Rural Appraisal, it brings active involvement of the community and subjectivity of non-cartographers into the spotlight. The crucial question is how one can choose the most optimal method for participatory mapping, taking into account the specific needs and assets of the community. In this paper, the author presents the ARAMANI tool, expert knowledge-based decision support system operating with 10 participatory mapping methods and experience of 172 survey responders. ARAMANI tool allows users to describe their community assets and needs while combining them with a value-based system for deciding which method to select. The tool is designed as a user-friendly webpage with guidelines and examples of best practices for each method.

Equal-Area Projections of the Triaxial Ellipsoid: First Time Derivation and Implementation of Cylindrical and Azimuthal Projections for Small Solar System Bodies P. 114-124

Maxim V. Nyrtsov, Maria E. Fleis, Michael M. Borisov & Philip J. Stooke

Abstract

Many small solar system bodies such as asteroids or small satellites have irregular shapes, often approximated by the reference surface of a triaxial ellipsoid. Map projections for the triaxial ellipsoid are needed to present the incoming data in the form of maps. In this paper the formulae of equal-area cylindrical and azimuthal projections of the triaxial ellipsoid were derived and practically implemented for the first time using as an example the asteroid 253 Mathilde. This paper is the final in a series of papers devoted to all main classes of projections of the triaxial ellipsoid. Before this, the authors obtained equidistant along meridians projection and Jacobi conformal projection for the triaxial ellipsoid.

Towards Better WMS Maps Through the Use of the Styled Layer Descriptor and Cartographic Conflict Resolution for Linear Features P. 125-136

Ionuţ Iosifescu Enescu, Nadia H. Panchaud, Magnus Heitzler, Cristina M. Iosifescu Enescu & Lorenz Hurni

Abstract

The Open Geospatial Consortium (OGC) Web Map Service Web Map Service | OGC, Open Geospatial Consortium (OGC), WMS. http://www.opengeospatial.org/standards/wms [Accessed March 31, 2015]. (WMS) and Styled Layer Descriptor Styled Layer Descriptor | OGC, Open Geospatial Consortium (OGC), SLD. http://www.opengeospatial.org/standards/sld [Accessed March 31, 2015]. (SLD) standards define a way of dynamically producing maps from vector data. However, this dynamic process often results in maps that are not easily readable when the underlying data are automatically represented at smaller scales than the original data were intended for. Fortunately, the SLD rules can be decoded, the symbolization rules translated into geometrical features, and cartographic conflicts detected and partially solved. The conflicting features can be identified based on the use of few basic geospatial analysis functions. After a solution that minimizes these conflicts emerges, new SLD rules are generated that attempt to visually solve the cartographic conflicts. The new SLD rules can then be applied on-demand by a cartographic proxy server that rewrites the incoming GetMap requests to use the new SLD rules. The process for improving the WMS cartographic output has several stages, grouped into preparatory steps (basic automatic generalization methods, rough scale-dependent SLD symbolization) and real-time processing steps (detection of cartographic conflicts, conflicts solution and generation of new SLD rules). The entire process of detecting and solving cartographic conflicts in the maps produced by WMS through the use of overriding SLD rules is described in detail. Furthermore, it is conceivable to transform the conflicting features into spatial objects containing methods for discovering appropriate SLD values that minimize conflicts. Such approaches can bring the performance of automatic detection and correction of cartographic conflicts above the threshold required for interactive visualization, thus, making the process of dynamically solving cartographic conflicts in WMS servers a viable solution.

Hypercube-Based Visualization Architecture for Web-Based Environmental Geospatial Information Systems P. 137-148

Ionuţ Iosifescu Enescu, Vassilios Vescoukis, Cristina M. Iosifescu Enescu, Fabian Müller, Nadia H. Panchaud & Lorenz Hurni

Abstract

The geospatial field significantly influences the development of the environmental domain, including a wide range of geospatial and cartographic information systems, such as Geographic Information Systems (GIS), Multimedia Atlas Information Systems (MAIS) and more recently web-based GIS (Web-GIS). In this context, we introduce web-based environmental geospatial information systems (Web-EGIS) as a special case of Web-GIS, aiming to integrate the functionalities of geospatial information systems with the enormous quantity of specialized, distributed and highly heterogeneous environmental geo-referenced data and services. We define three main characteristics of the Web-EGIS. The first is a generic hypercube-based data organization and visualization. The next characteristic is a standard-based, three-tier service-oriented architecture. The third and last characteristic

is the traceability of the architectural and design decisions, for which we introduce the new concept of an 'Environmental Application Context', arguing that not only the functional but also the non-functional requirements (NFRs) have an important role in defining the architecture, software components and data services of such systems. In a nutshell, a Web-EGIS is characterized by a coherent user experience through the hypercube-based visualization concept, technically supported by a service-oriented architecture that is structured according to an extensive analysis of NFRs. On this basis, we introduce the Geodata visualization and interactive training environment (GeoVITe) Platform for Interdisciplinary Environmental Research as a reference implementation of a Web-EGIS with its basic design requirements, integrative hypercube-based visualization for heterogeneous data sources, extended web cartography functionalities, and its *de facto* system architecture. The concept of the hypercube-based visualization is better transferred to the system architecture by understanding the 'Environmental Application Context' of this particular Web-EGIS, which also makes it easier to maintain and enhance. The resulting system is a support platform for research activities in the environmental domain.

Symbolization and Generalization to Map Water Pipe Data Flow and Water Quality at Different Scales P. 149-158

Anne Ruas & Ha Pham

Abstract

Mapping drinking water flow is a real challenge not only to detect water leaks but also to control the quality of the water. In France, 900,000km of water pipe serves 99% of the population. A recent law imposes the mapping of these pipelines on a known geographical system with a planar positional accuracy from 0.4 to 1.5m according to the age and type of the pipeline. Wireless sensors and models based on computational fluid mechanics (CFD) allow to study flow and to reconstruct parameters such as velocity, pressure and a chemical concentration at each point. This information can be used to detect leaks and to control the concentration of chlorine or other chemical products. However, this information is not easy to map on GIS due to the small width of water pipe and the very high quantity of points necessary for data flow computation. In this research work, we propose solutions to map this information at different levels of detail with other information such as roads and buildings. We first propose to use area symbols instead of punctual symbols to improve zoom-in visual effects. We also propose to generalize initial water data for zoom-out processes. We use the axis of the water pipe as basic geometry and we segment it. We then compute a generalized value of pressure, velocity or chemical concentration for each segment with specific function adapted to the property we wish to study. We propose a conceptual data schema that describes the required information to map this data at different levels of detail. The solution has been fully implemented on experimental data and illustrated by means of a dedicated web mapping that proposes a set of GIS functions such as the selection of the data, zooming functions but also the animation to see the propagation of a chemical product in the water pipe.

Maps as Knowledge Aggregators: from Renaissance Italy Fra Mauro to Web Search Engines P. 159-167

Andrea Nanetti, Angelo Cattaneo, Siew Ann Cheong & Chin-Yew Lin

Abstract

Mediaeval and Renaissance maps of the world were and worked as knowledge aggregators. The cosmographers identified, selected and re-edited information about hundreds of places from a variety of literary, iconographic and oral sources, and synoptically re-organized them in place names, cartouches, and drawings to be put on a map. This selection/aggregation process transformed the mappa mundi into a visual encyclopaedia (i.e. an all-around learning and thinking tool), where each geographical entry was able to generate narratives as a data gateway and an information hub for customs, commodities, and rulers of different peoples of the world. If we infer that the Renaissance people asked to the cosmographers to learn about the world as we go to search engines to find what we want, the reverse engineering of these works (as exemplified in this paper for the mid-fifteenth-century world map by Fra Mauro Camaldolese) can help to draw the connection between the traditional way to aggregate knowledge as a product (e.g. Fra Mauro's mappa mundi) and the modern way of using search engines and related internet services (i.e. their map services) to serve a similar purpose but in a better and more dynamic manner, placing crucial question, such as: How the same networks/people can bring new wealth and development, or war and poverty? Which are the dynamics of sustainability in international

mechanisms?

Automated Generation of Schematic Network Maps Adaptive to Display Sizes P. 168-176

Peng Ti, Zhilin Li & Zhu Xu

Abstract

Schematic maps have been popularly used for the representation of metro (or underground) lines and nowadays have also been used for the representation of other network maps. This paper presents a strategy for automated generation of schematic network maps for different display sizes, based on a redistribution of line density. This strategy consists of three steps: (a) estimation of spatial density of the network maps, (b) automated redistribution of line density in order to improve map clarity, for different display sizes, and (c) automated generation of schematic representations. An experimental evaluation has been carried out by using two sets of real-life network data. The results indicate that this strategy is able to generate schematic maps with much improved clarity for different display sizes and well-preserved map recognition.

Testing the Usability of OpenStreetMap's iD Tool P. 177-184

Jan Behrens, Corné P. J. M. van Elzakker & Manuela Schmidt

Abstract

The objective of this study is to investigate the usability of the iD editor of OpenStreetMap (OSM). To this end a usability test with 18 participants has been conducted. The participants were given mapping tasks to complete using iD and observed with the thinking aloud method as well as screen recording and mouse/keyboard logging. Additionally, the test persons were interviewed after each test. The data gathered were analysed with regard to key usability criteria such as learnability, efficiency, error tolerance, and subjective user satisfaction. The outcome of this study is the identification of usability issues from which possible improvements of the tool have been derived. The study shows that iD is an overall usable tool for novice users, but still shows opportunities for improvement especially in terms of learnability and error handling.

Automated Extraction of Natural Drainage Density Patterns for the Conterminous United States through High-Performance Computing P. 185-192

Lawrence V. Stanislawski, Jeff Falgout & Barbara P. Buttenfield

Abstract

Hydrographic networks form an important data foundation for cartographic base mapping and for hydrologic analysis. Drainage density patterns for these networks can be derived to characterize local landscape, bedrock and climate conditions, and further inform hydrological and geomorphological analysis by indicating areas where too few headwater channels are represented. Natural drainage density patterns are not consistently available in existing hydrographical data bases for the United States because compilation and capture criteria historically varied, along with climate, during the period of data collection over the various terrain types throughout the country. This paper demonstrates an automated workflow that is being tested in a high-performance computing environment by the U.S. Geological Survey (USGS) to map natural drainage density patterns at the 1:24,000-scale (24K) for the conterminous United States. Hydrographic network drainage patterns may be extracted from elevation data to guide corrections for existing hydrographic network data. The paper describes three stages in this workflow including data pre-processing, natural channel extraction, and generation of drainage density patterns from extracted channels. The workflow is implemented in parallel fashion by simultaneously executing procedures on multiple subbasin watersheds within the U.S. National Hydrography Dataset (NHD). Pre-processing defines parameters needed for the extraction process. Extraction proceeds in standard fashion: filling sinks, developing flow direction and weighted flow accumulation rasters. Drainage channels with assigned Strahler stream order are extracted within a subbasin and simplified. Drainage density patterns are then estimated with 100-m resolution and subsequently smoothed with a low-pass filter. The extraction process is found to be of better quality in higher slope terrains. Concurrent processing through the high-performance computing

environment is shown to facilitate and refine the choice of drainage density extraction parameters and more readily improve extraction procedures than conventional processing.

How Do Map Readers Recognize a Topographic Mapping Style? P. 193-203

Jérémie Ory, Sidonie Christophe, Sara Irina Fabrikant & Benedicte Bucher

Abstract

The process of reading a topographic map requires users to recognize and learn the cartographic symbols of the key (or legend) while interpreting the territory as depicted on the map at a given level of abstraction (the form and nature of features, their saliency and relationships). We present the results of an empirical user study that aims to identify and assess the main graphical characteristics that are used by map users to recognize the design principles which constitute the topographic mapping style adopted by IGN (Institut National de l'Information Géographique et Forestière), France. Our results suggest that 91% of the participants were able to recognize an IGN-France topographic map amongst other topographic map products. We also determine which graphical characteristics play a role in the recognition of this cartographic style, either by visual memory or by visual perception, and identify the representation of relief, including contour lines and shaded relief, as one of the major graphical characteristics of the topographic mapping style of IGN-France. Moreover, the participants of our study considered the representation of touristic POI (points of interest), toponymy, typography, the main roads network, the individual buildings and the forests, to be essential for stylistic recognition.

Adaptive Relative Motion Representation of Space–Time Trajectories P. 204-209

Antoni B. Moore & Judy Rodda

Abstract

Many devices are now geared towards collecting spatiotemporal data on a massive scale. Trajectory data of objects form a large component of this resource and even the smaller trajectory datasets are a representational challenge for cartography. We present a method that regularizes mapped trajectory data into an object□×□time interval matrix to better compare the direction characteristics of objects. We use a simulated annealing method to optimize the order of object rows at a specific time interval so that objects that are close together in space tend to be close together in the matrix. We also graphically represent the distance between objects and the general direction the object is travelling in the matrix, which is called Adaptive Relative Motion (ARM). Finally, we demonstrate the implementation of ARM through a case study of dolphin trajectories.