Design and development of a system for vario-scale maps

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ABSTRACT

Nowadays, there are many geo-information data sources available such as maps on the Internet, in-car navigation devices and mobile apps. All datasets used in these applications are the same in principle, and face the same issues, namely:

1. Maps of different scales are stored separately. With many separate fixed levels, a lot of information is the same, but still needs to be included, which leads to duplication.

2. With many redundant data throughout the scales, features are represented again and again, which may lead to inconsistency.

3. Currently available maps contain significantly more levels of detail (twenty map scales on average) than in the past. These levels must be created, but the optimal strategy to do so is not known.

4. For every user’s data request, a significant part of the data remains the same, but still needs to be included. This leads to more data transfer, and slower response.

5. The interactive Internet environment is not used to its full potential for user navigation. It is common to observe lagging, popping features or flickering of a newly retrieved map scale feature while using the map.

This research develops principles of variable scale (vario-scale) maps to address these issues. The vario-scale approach is an alternative for obtaining and maintaining geographical data sets at different map scales. It is based on the specific topological structure called tGAP (topological Generalized Area Partitioning) which addresses the main open issues of current solutions for managing spatial data sets of different scales such as: redundancy data, inconsistency of map scales and dynamic transfer. The objective of this thesis is to design, to develop and to extend the variable-scale data structures and it is expressed as the following research question:

How to design and develop a system for vario-scale maps?

To address the above research question, this research has been conducted using the following outline:

1. Investigate state-of-the-art in map generalization.
2. Study development of vario-scale structure done so far.
3. Propose techniques for generating better vario-scale map content.
4. Implement strategies to process really massive datasets.
5. Research smooth representation of map features and their impact on user interaction.

Results of our research led to new functionality, were addressed in prototype developments and were tested against real world data sets. Throughout this research we have made following main contributions to the design and development of a system of vario-scale maps. We have:

- studied vario-scale development in the past and we have identified the most urgent needs of the research.
- designed the concept of granularity and presented our strategy where changes in map content should be as small and as gradual as possible (e.g. use groups, maintain road network, support line feature representation).
- introduced line features in the solution and presented a fully-automated generalization process that preserves a road network features throughout all scales.
- proposed an approach to create a vario-scale data structure of massive datasets.
- demonstrated a method to generate an explicit 3D representation from the structure which can provide smoother user experience.
developed a software prototype where a 3D vario-scale dataset can be used to its full potential. conducted initial usability test.

All aspects together with already developed functionality provide a more complex and more unified solution for vario-scale mapping. Based on our research, design and development of a system for vario-scale maps should be clearer now. In addition, it is easier to identified necessary steps which need to be taken towards an optimal solution. Our recommendations for future work are:

- One of the contributions has been an integration of the road features in the structure and their automated generalization throughout the process. Integrating more map features besides roads deserve attention.
- We have investigated how to deal with massive datasets which do not fit in the main memory of the computer. Our experiences consisted of dataset of one province or state with records in order of millions. To verify our findings, it will be interesting to process even bigger dataset with records in order of billions (a whole continent).
- We have introduced representation where map content changes as gradually as possible. It is based on process where: 1) explicit 3D geometry from the structure is generated. 2) A slice of the geometry is calculated. 3) Final maps based on the slice is constructed. Investigation of how to integrate this in a server-client pipeline on the Internet is another point of further research.
- Our research focus has been mainly on one specific aspect of the concept at a time. Now all aspects may be brought together where integration, tuning and orchestration play an important role is another interesting research that desire attention.
- Carry out more user testing including; 1) maps of sufficient cartographic quality, 2) a large testing region, and 3) the finest version of visualization prototype.

REFERENCES


Heidelberg. (Cited on pages 23 and 26).


Building up on this background of land development and the growth of the business, with a mere 10% eventually remaining in the control of the old spatial unit is derived then through the definition of top and bottom face. Spatial unit is derived then through the definition of top and bottom face. 3D Cadastre in China - GDMC. Renzhong Guo, Lin Li, Biao He, Ping Luo, Shen Ying, Zhigang Zhao and Renrong Jiang. An example of a 5D search that appears in space, time, and scale context is the integration of a database with physical plans at different moments in history and a database with historical information on buildings to check which buildings (extensions) conflict with which status of the physical plan. Database design for a multi-scale spatial information system. International Journal Geographic Information Science, Vol. 10, pp. 901-920. No 18 (2017): Design and development of a system for vario-scale maps. Book (Full version). Techniques for better vario-scale map content. Radan Šuba TU Delft, Architecture and the Built Environment. Abstract. The previous chapters covered the research where the vario-scale structure has been introduced. So far, the technical aspects had higher priority than the map content. Therefore, this chapter focuses on improving our development kit for generating vario-scale content. It presents a strategy to provide good cartographic results throughout all scales and properly stored in the structure. First, Section 4.1 specifies our target. Section 4.2 presents solutions of other researchers. Section 4.3 introduces concepts and tools which are used later in newly designed process. No 18 (2017): Design and development of a system for vario-scale maps. Book Chapters. Vario-scale data structures. Radan Šuba TU Delft, Architecture and the Built Environment. https://doi.org/10.7480/abe.2017.18.3592. Abstract. More specific, Section 3.1 and 3.2 provide historical overview of the development and the theoretical framework for vario-scale representations: the tGAP-structure (topological Generalized Area Partitioning). Section 3.3 describes the initial effort to generate the better cartographic content; the concept of constraint tGAP. Section 3.4 explains the 3D SSC (Space-Scale Cube) encoding of 2D truly vario-scale data. Section 3.5 shows idea how to combine more level of details in one map.