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Review of the Doctoral Thesis

of Lukas Bruha, M.Sc.

title: Feature-based Multi-resolution Topography

Supervisor: Dr. Tomas Bayer, Charles University in Prague

Introduction

The Dissertation of Lukas Bruha contains 134 pages, 7 chapters, 36 figures, and 11 tables. His research is based on large number of references, related to the topic. The dissertation has contemporary and modern aspects described by the research objectives.

The thesis covers the problem with unification of referenced geo-data to different scales and perspectives. Good solutions will allow many different applications for science, education, visualization and new practical geo-products. Multiple levels of detail (LOD) of spatial objects will give a new vision of representation of topographic surface by a multi-resolution visualization. This is also one of the aims of Digital Earth as a technology and society for data management conditions and solutions.

Structure of the Thesis

Research motivation, questions, objectives, scope of the study and structure of dissertation are clearly explained in Chapter 1. The previous works on spatial data modeling and dimensionality, multi-resolution topography, cartographic generalization, and big data management are presented in Chapter 2. In Chapter 3, the indexing LOD mechanism is proposed and adopted on the base of 3 preferences- for minimal data

redundancy, for the procedural solutions and for non-projected solutions. Some of basic problems are discussed and solutions are proposed in Chapter 4 – simultaneous simplification algorithm, the method for the reconstruction of topographic surface. Chapter 5 shows more 2 contributions in preservation of terrain morphological structure and achievements in visualization and spatial analysis. The demonstrations and implementations of achieved contributions are shown in Chapter 6 – footprints' analysis, multiple LOD database and run-time recognition of the topographic surface. The contributions are shown in the last Chapter 7.

The Thesis structure is well done, following logically topics to receive the results of all tasks.

Thesis' Review

The main motivation of the research is that the results will be in great importance for realization the global feature-based topographic surface by multiple LOD. Because of this Lukas Bruha analyses many related works in topics of different perspectives on real world modeling, dimensionality of data, multi-resolution digital terrain models, multiple levels of detail, and interaction of terrain models in Chapter 2. Very good critical analyses are made in this dissertation and as well they become a base for future contributions.

Deeply discussed fundamental choices for the solutions of digital Earth can be found in Chapter 3- these are 3 preferences for minimal redundancy, for procedural and for non-projected solutions. The used global indexing and paging mechanism for multiple LOD data management is correctly provided.

It is good decision to use hybrid (2,5D/3D) model which lead to better and faster modeling of the earth surface. This is discussed in Chapter 4. There is an achieved multi-resolution terrain with different kinds of features in multiple LOD environments. The PhD candidate used the latest IT achievements as well as the best publication in the topic and on this base made own conclusions and contributions. The proposed method for analysis of footprints will simplify the preconditions, facilitate addition of independent features, and process the attributes for spatial objects. The work is continued into the relation between the bare Earth model and the footprints of spatial objects on multiple levels of detail.

The simplification guide of features with regard to terrain and preservation of selected features of terrain on LOD are detailed discussed in Chapter 5. Special attention is done to the break-lines in the terrain shape which topic is very important for receiving of correctly designed terrain model. The experiments are done on the base of an application of OpenStreetMap and of the terrain morphology network for the multiple LOD topography. The results are shown in Chapter 6 by several experiments about the functionality and behavior of the methods discussed in previous chapters.

All graphical applications - figures and tables are made readable and clear.

Summary and Conclusion

The dissertation has contemporary and very modern aspect described by seven research chapters. The topic is very important not only for science but for many practical approaches. The science and industry could use the results achieved in the thesis for future contributions and developments.

The following positive points can be stressed:

1. The research subject is unique for the development of cartography and topographic industry.
2. The provided analyses fully correspond to the all aims of the thesis.
3. The research topics, the methodology and methods are consistent, corrected and used appropriated.
4. The results are derived logically and well described. They are analysed and interpreted in accordance with the scientific standards and discussed in the GIS and cartographic community.
5. The literature references are correctly cited.
6. The thesis clearly demonstrates that Lukas Bruha can conduct independent scientific research and future research work carried out by him independently will meet the standards of his scientific community.

I accept the contributions presented by the PhD candidate on page 119 of his thesis.

The following points have to be mentioned as potential weakness of the thesis:

1. The place of definitions of topography could be in other part than in point 1.1. Motivation (p.3).
2. When we work with a topographical surface, ellipsoid should be preferable shape than sphere (pp.30-32).
3. I would like to ask the PhD candidate if he can formulate more practical applications of the proposed methods and achievements in the dissertation.

The PhD Study is very important and coming in time of multi-disciplinary projects developments. It could be the base point not only for researchers but also for geo-business needs. The minor weakness points cannot influence of the final assessment of the thesis results and I would like strongly recommend to the scientific committee to award the PhD degree to Lukas Bruha.



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