Abstract

A three-dimensional (3D) representation of the topographic surface is an important element in planning, civil engineering and mapping. Many state-of-the-art representations provided graphical, 3D model of entire planet. However, the existing solutions to 3D topographic surface lack the geometric flexibility and accuracy on boundaries with models of other geographic features. Most of the contemporary approaches to digital Earth solutions focus on the visualization performance. The high visual performance is achieved by the use of special data structures optimized for rendering. However, this optimization towards visualization hampers the data management of spatial data, their analysis and distribution.

Therefore, the introduced solution reflects on multiple requirements of digital Earth systems. In addition to the visualization performance, the requirements regarding data interoperability, data management and distribution, data analysis and the multiple level of detail (LOD) are considered as essential for the design of the new solution.

The topographic surface is central to the proposed method. It provides the defining surface in terms of which other features can be geographically referenced to. Therefore, this work introduces a new, more functional data representation of multi-resolution topographic surface. This representation is globally applicable, allows to populate the terrain surface with new geographic features and supports the multiple LOD of both features and terrain.

The presented solution to representation of spatial features for multiple LOD environment is rooted in the concept of footprint. Exploitation of this concept alleviates from the structural complexity of pure 3D solutions, however, it also supports the extension to true 3D, when needed. This work extends the existing usage of footprints by providing support for multi-resolution representation. Consequently, the footprint can be represented with variable resolution along its course in the reconstructed graphic scene. In a pursuit of interoperability, the method for footprint analysis is developed

to deal with features originating from disparate data sources. Thereafter, the algorithm for simultaneous simplification of a set of footprints is proposed. It is designed to build the multiple LOD database of features in such a manner, that the topological relations between features are preserved in the multiple LOD environment, which is reconstructed on its grounds.

Since the topological relation between the feature and terrain is essential for many geo-spatial analyses, this thesis proposes two methods to carry out the generalization of distinct spatial features with respect to the geometry of terrain. It is also shown, how the important morphological structure of the terrain can be obtained and subsequently preserved on coarser levels of resolution.

The method introduced in this thesis employs the Global Indexing Grid (GIG) as an indexing and paging mechanism. GIG determines for any position of the observer within the 3D virtual environment the position-dependent LOD of currently visible features and underlying terrain.