Spatio-Temporal Data Handling for Generic Mobile Geoinformation Systems

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Abstract: Within this extended abstract, a workflow for an efficient and practical handling of spatio-temporal data is presented. The workflow consists of three layered parts. The first part is the efficient management of spatio-temporal data. The second part focuses on the development of Web services for the dissemination of spatio-temporal data. The third part is a generic mobile GIS for professional users as a typical application for the spatio-temporal data management model and the related Web services.

1 Motivation and Prior Work

The data basis of diverse scientific disciplines consists of data with a spatial reference (TORGE 2003; BARTELME 2005; LI 2015; DAO et al. 2015; WEIHED 2015). Among others PEUQUET (1984), MALLET (2002), WORBOYS (1992), POULIOT et al. (2013), GABRIEL et al. (2015) and BREUNIG et al. (2016) focused on the on the use of simplicial complexes in a 3D space for the modelling of natural surfaces. With a fourth dimension (time) the already huge amount of data that needs to be processed increases. Therefore, the handling of such data is a major challenge.

WORBOYS (1994), GÜTING & SCHNEIDER (2005) and LE (2014) focused on the handling of time within spatio-temporal data. WORBOYS (1994) proposes two separated time dimensions: transaction time and valid time. The transaction time stands for the date on which the data is added into a system, whereas valid time describes the time of the event, which is represented by the data. In some cases additional requirements are needed for the management of time, e.g. for construction projects it is necessary to differentiate between a planning time and a realization time. In such a case the time is also managed in two separated dimensions. The planning time reflects the planning of structures and the realization time reflects the progress of the construction (BREUNIG et al. 2011). When handling time one important aspect is the treatment of time intervals. ALLEN (1984) specified multiple relationships of temporal events. These were used by BREUNIG (2001) in the context of spatio-temporal data management.

Issues that were addressed in former research focus mainly on one of the following subjects: geometry, topology or time. In this abstract a concept is presented that considers all three aspects for an efficient handling of spatio-temporal data and forms the basis for the dissemination of such data for mobile GIS. This extended abstract is a brief overview of the outcome of my dissertation (KUPER 2016).

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2 Concept

The workflow for an efficient and practical handling of spatio-temporal data can be divided into three layered parts. The first part focuses on the efficient management of spatio-temporal data itself. The data management model that was developed consists of the five concepts Point Tubes, Delta Storage, Topology Management, Handling of Thematic Data, and Net Components. These concepts were adapted to manage spatio-temporal data which is based on simplicial complexes in a 3D space. The comprehensive model that combines the benefits of these partial concepts was realized within a database management system.
The second part focuses on the development of Web services for the dissemination of spatio-temporal data. For this purpose, two Web services that are based on the OGC standards Web Processing Service and Web Feature Service were developed. The use of OGC standards simplifies the realization of multiple client applications and the combination and integration with existing geodata infrastructures. With the two Web services spatio-temporal data can be distributed and spatio-temporal operations can be processed on a server.
As a third part of the workflow a generic mobile GIS application for professional users was developed as one typical application for the spatio-temporal data management model and the related Web services. First, a universal concept for generic mobile GIS was developed. Afterwards, this concept was extended to include the specific requirements for the handling of spatio-temporal data. An overview of the entire workflow is shown in Figure 1.

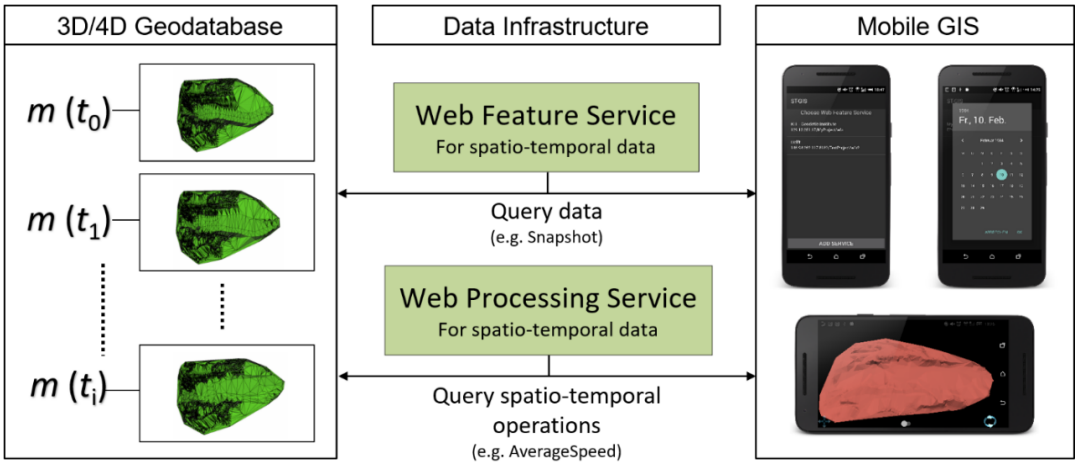

Fig. 1: Overview of the entire workflow based on three layered parts.

Explicit implementations for all three parts of the workflow are provided as free and open source software and are partially integrated into the 3D/4D geodatabase architecture DB4GeO (BREUNIG et al. 2016).

3 Results and Outlook

With the data management model, it is possible to handle various kinds of spatio-temporal applications. Such applications can include massive changes between consecutive time steps and a differentiated handling of thematic and semantic data. Variable temporal discretizations of partial regions of a spatio-temporal model are managed accordingly. It was shown that the data management model reduces the storage requirements for the handling of spatio-temporal models and accelerates computational operations significantly.
In the future the current workflow can be extended and 3D/4D modelling tools such as GOCAD can be integrated. Another promising group of components for the workflow are virtual reality (VR) devices such as Oculus Rift or HTC Vive.

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