TOWARDS FULLY AUTOMATED 3D CITY MODEL GENERATION - FROM AIR, TERRESTRIAL AND MOBILE

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Extended Abstract

The demand for 3D city models is considerably increasing, a phenomenon triggered not only by virtual globes such as Google Earth, Microsoft Bing Maps 3D, and the car navigation sector but also by applications like city climate simulations, solar energy potential estimations and many more. Therefore, the automated 3D city model generation is one of the challenging tasks of those virtual globe service providers and the car navigation industry. In parallel, National Mapping and Cadastral Agencies (NMCAs) are extending their 2D spatial data provision with 3D building models, and most recently with 3D city models, in LoD2 detail. The LoD2 presentation contains the 3D shape of the building walls with complex roof structures and, moreover, is rendered by 2D image textures. By the way, LOD0 is just the digital terrain presentation and LoD1 a shoebox-like 3D presentation of the buildings.

Civil engineering analyses are demanding for more complex and more realistic 3D building models, such as LoD3, which contain specific building structures of facades (windows, doors, etc) to improve their FEM software tools for planning of new underground lines, streets, bridges, tunnels etc. Therefore there is a need for highly automated reconstruction tools to fulfill those requirements. New developments in computer graphics, virtual reality, and serious gaming would like to have 3D indoors models as well, leading to LoD4.

The Institute for Photogrammetry, University of Stuttgart is working since about 20 years in the field of fully automated 3D city modeling. Starting with the unwrapping of point clouds delivered by airborne laser scanning (ALS) just recently we implemented software tools to provide very dense point clouds from airborne imagery, by the methods of Semi Global Matching (SGM). Those methods deliver a 2D sampling density of up to 400 points per sqm (GSD 5cm) and are superior compared with ALS (40-60 ppsqm). An automated processing pipeline is available starting with 3D point clouds, independent of the source (ALS, airborne photography), followed by automated 3D building unwrapping, 3D building texturing, 3D building generalization (if necessary) and the extraction of 3D building structures. A software package has been developed and delivered to a SME which is using this pipeline for generating a good business in the area of 3D city model generation. This package was proven in a pilot project – the generation of 3D Berlin, with 476.000 buildings covering an area of about 890sqkm. A video will show the potential of the processing pipeline. As dense image matching is concerned the ifp software package SURE is explained which is available on the Web for academic institutions free-of-charge. Most recent developments can process nadir and oblique view imagery to complement the bird’s eye point clouds by very dense façade point clouds.

The point clouds for the processing of facades to deliver structural elements are collected by kinematic and/or mobile mapping systems. Some examples demonstrate the great potential of those emerging technologies, which will not only monitor existing infrastructures but can

also be used for railway mapping, streets/bridges inventory purposes and powerline mapping. The Institute for Photogrammetry has developed a grammar for the semantic enrichment LoD2 models to finally deliver LoD3. This grammar is very powerful and can analyse point clouds as well as photos, sequentially or simultaneously. Several architectural styles can be interpreted, in an integrated workflow which starts data-driven, provides the knowledge for a knowledge engine and predicts knowledge to those facades/areas with false or missing data.

As the grammar can also be used for 3D indoor modeling, to allow for crowd-sourced mapping within public buildings, we present also an automatic method for the reconstruction of building interiors given in Manhattan geometry. The sweep-based algorithm can automatically interpret point clouds collected by terrestrial laser scanning, dense image matching or low-cost devices such as MS Kinect. Some example will demonstrate the power of this new approach.

Finally the paper concludes with some visions and missions for the near future. Computer games will become more and more realistic and are therefore clients of 3D city modeling, no matter of playing in outdoors or indoors sceneries. A most recent demand is given by National Mapping and Cadastral Agencies (NMCAs) which would like to have updates of 3D city models. Not to forget the update cycles of virtual globes with the aim to get more and more a better 3D presentation of 3D cities as well.