

3D point cloud interpretation for facade reconstruction

3D city models are of growing interest in various application areas. For instance, they are the basis for city planning, virtual sightseeing tours or simulations. Meanwhile, due to internet services such as Google Earth or Microsoft Bing Maps, 3D representations of buildings are becoming ubiquitous and find their way to the general public. The increasing demand for 3D building models requires efficient reconstruction techniques with a high degree of automation. Mostly generated from airborne LiDAR or image data, building models usually feature detailed roof shapes but planar, unstructured façades. However, new developments in the areas of computer graphics, the entertainment industry or navigation systems push the demand for more complex and realistic models. The desired amount of detail is not limited to geometric aspects, but also includes semantic information about the façade. Frequently, terrestrial LiDAR point clouds and images are used to extract high resolution building structures for the enrichment of planar façades. Such a purely data driven bottom-up modelling only leads to robust and realistic façade models if the available observations are of high quality. Depending on sensor accuracy and the geometric configuration during data acquisition, measurements often exhibit heterogeneous quality situations concerning accuracy, coverage and density. This holds true for data from specialised sensor systems, when for example obstacles lead to partial occlusions, as well as particularly for data from low cost sensors. To ensure the generation of realistic 3D geometries even for inaccurate and incomplete measurements, reconstruction has to be supported by additional object information. Algorithms introduce knowledge about objects through predefined rule systems for procedural modelling of building structures in a certain architectural style.

We aim at the refinement of existing coarse building models by integrating three-dimensional façade geometry with explicit semantic information, for example windows or doors. The façade reconstruction ought to run fully automatically. Furthermore, the approach should be robust against erroneous and incomplete sensor data, but not subject to prespecified rules. For this purpose, bottom-up and top-down strategies are combined. The data driven part is mainly based on terrestrial LiDAR data and applies cell decomposition for the modelling process. Building areas covered by dense and accurate measurements are used to extract 3D façade geometries. Resulting façade models contain structures which are characteristic for the respective building and, thus, serve as knowledge base for the automatic derivation of a formal grammar called façade grammar. In a first step, the façade is segmented into semantically homogeneous regions representing basic elements of the grammar, the terminals. Expressed as a sequence of terminals, the façade can subsequently be searched for repetitive and hierarchical structures by means of a string based algorithm. After the detected structures have been automatically translated into production rules, the façade grammar is complete. It holds all the information which is necessary to reconstruct buildings in the style of the observed façade. By applying the rules, realistic façade structures can be generated even for building regions for which no sensor data or only measurements of poor quality are available.