PhD position proposal 2014

Semi-automatic editing, fitting and refinement of 3D city models

Keywords : 3D reconstruction, 3D city models, photogrammetry, computational geometry

Context

3D city models are used more and more commonly for an increasing number of applications such as urban planning, tourism, communication, navigation, augmented reality, physical simulations (flood, wave propagation in telecommunication, micro-meteorology...). These 3D city models are generated from georeferenced remotely-sensed datasets such as satellite, airborne and mobile mapping-based images and lidar point clouds.
If fully automatic modeling aims to process the raw data in bulk and thus at reduced costs, it is hard to guarantee a specified level of geometric and semantic fidelity. Therefore, human intervention is required to provide a modeling of certified quality, through semi-automatic editing, fitting and refinement of the 3D city model.

Subject

Given a possibly incomplete or erroneous 3D city model and a collection of georeferenced datasets, the goal of this PhD is to propose semi-automatic tools that enable the efficient edition of the 3D city model, based on these georeferenced datasets, which may or may not be the datasets used for the initial automatic constitution of the model. IGN's mobile mapping system, STEREOPOLIS, provides calibrated images and 3D point clouds which are precisely georeferenced (and thus coregistered) by a combination of GPS, IMU and Odometry-based direct georeferencing and photogrammetric post-processing. The 3D city model to be modified may be of metric accuracy (BD TOPO, available over the whole French territory), of decimetric accuracy (Bati3D, available in a number of cities) or even more accurate.

Using their relative georeferencing, the acquired datasets and 3D city models may be browsed interactively and covisualized from streetside or aerial perspectives. The goal of the proposed PhD position is to provide simple image-based 2D interactions on one or multiple images, that enable the modeling and editing of the 3D city model in the most efficient way (minimum number of click). While it is easy to input new geometry as an unordered set of points and line segments, maintaining topological guarantees such as a watertight polyhedral surface is primordial yet much more difficult. The work of [Brédif] proposes a polyhedral fitting algorithm based on a point set that handles implicitly the necessary topology changes. A possibility would be to extend this work to incorporate simple user interactions that would enable the user to hint at high level topological modifications (splitting a roof facet, merging approximately coplanar roofs…) while using the topology-aware geometric fitting to drive the geometric optimisation and cumbersome low-level topological modifications : eg the placement of short edges between nearly colocated polyhedral vertices such that adjacent facets do not self intersect. Where data is of insufficient quality or density, it is customary to enforce geometrical constraints (parallelism, horizontality, orthogonality...) [Taillandier]. User interaction should be adapted to visualize and edit these constraints efficiently and embed them in the topology-aware geometric fitting.

Profile

- Master-level education in computer science and/or geomatics.

- Very good knowledge of the C++ programming language is mandatory.
- Good spoken and written English. Knowledge of French would be useful.
- Some experience in 3D geometry, computer graphics and HCI is highly recommended.

Location and salary

Research will be held at the MATIS laboratory of the Institut National de l'Information Géographique et Forestière (IGN) in Saint-Mandé, Paris, France (94).
The wages will be around 1 500 € per month.
The position will be for 3 years, and may start on September 2014.

The MATIS laboratory of the Institut National de l'Information Géographique et Forestière (IGN), which is the French Mapping Agency, is specialized in photogrammetric computer vision, image analysis and remote sensing from both satellite, airborne, mobile mapping imagery and ground based imagery (Lidar + images). It is composed of 40 researchers, including 17 permanent researchers. The MATIS laboratory has been involved in 3D data collection for 3D city modelling for twenty years.

Contact

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Application

Applications consist of a cover letter describing how your research or engineering experience is relevant to the position, a resume and a publication list. They should be addressed jointly to both the supervisor mathieu.bredif@ign.fr and the human ressources department sref@ign.fr .
Please contact the supervisor for more information about any aspect of the position and research topic.

Application deadline : April 30, 2014

References

[Brédif] M. Brédif. *3D Building Modeling : Automatic Roof Superstructure Reconstruction and Kinetic Topology-Aware Polyhedral Roof Fitting*. PhD thesis. Telecom ParisTech/EDITE. 2010
http://mathieu.bredif.free.fr/these/bredif_thesis.pdf

[Taillandier and Vallet 2005] F. Taillandier, B. Vallet. *Fitting Constrained 3D Models in Multiple Aerial Images*. BMVC, Oxford, UK, 2005.
http://www.comp.leeds.ac.uk/bmvc2008/proceedings/2005/papers/176/Vallet_Taillandier_BMVC2005.pdf