Open PhD position:

A joint geometrical and semantic approach to reconstructing digital model using UAVs

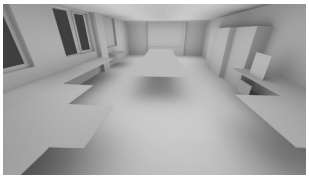
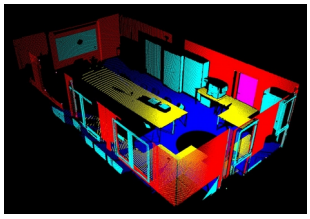
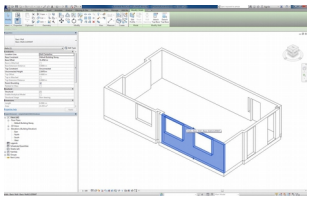
Context

Digital models are increasing used in the industry, not only for cars or planes but also for buildings (BIM). They capture both the geometrical and semantic information related to the construction and to its use. Models are most often created before new objects are built, precisely to guide their construction. They are little used for existing objects. Yet, having a model for existing objects is extremely useful, for instance for defect detection, simulation or operation planing.

Digital models are currently produced manually or semi-manually, typically from data captured with a lidar (laser scanner) on a tripod. This acquisition process is tedious because the tripod has to be manually moved from on place to another. Besides, it prevents acquiring data in ares whose access is difficult, e.g., a roof or the stairs of a building.

PhD topic

The proposed PhD thesis concerns the use of autonomous UAVs, with embedded sensors, for the construction of digital models. This solution offers much more flexibility for acquiring data in areas difficult to access. It also facilitates repeated data acquisitions to monitor in time issues that could be critical for maintenance. It also allows focusing on locations where abnormal details are observed with respect to an expected model.

Several studies have shown that sequentially treating geometry, then semantics can lead to errors and incomplete models because of initial defects data acquisition and geometry modeling. On the contrary, recent work has demonstrated the semantic priors can help geometric reconstruction [Guney 2015]. The goal of this thesis is to couple geometry and semantics in the model construction process. Relevant work in model reconstruction with semantics and geometric issues include [Boulch 2013, Boulch 2014, Handa 2015, Monszpart 2015].

The labs

This thesis is a collaboration between ONERA (the French national aerospace research centre) and Ecole des Ponts, also called ENPC (one of the top scientific school in France). ONERA is developing minidrones that are particularly well suited for the task.

As for Ecole des Ponts, the IMAGINE project in the LIGM lab is a strong research group on computer vision and machine learning. It has a long record of developing techniques for 3D reconstruction and semantic analysis. Previous members of IMAGINE transferred technology that had been developed in the group and founded the successful Acute3D company (2011). IMAGINE also won the PRoVisG Mars 3D Challenge (2011) and got the first position on the PASCAL VOC2012 comp4 object detection leaderboard with CNN-based technique (2015).

This thesis is located in the Paris area. The PhD student will spend more or less half of its time at ONERA (Palaiseau center) and half of its time at ENPC (Marne-la-Vallée).

The thesis is co-supervised by Renaud MARLET (ENPC) et Alexandre Boulch (ONERA).

Profile of applicants

- very strong academic record with an excellent degree (M.Sc., M.Eng. or equivalent) in Computer Science, Mathematics, or a related field (e.g. Electrical Engineering),
- excellent knowledge in computer vision, good knowledge in machine learning, and at least basic knowledge in computational geometry,
- very good programming skills.

Application

To apply, please email:

- your CV,
- a transcript of your MSc grades/marks (even if incomplete),
- a report you wrote for your MSc thesis or for a previous internship,
- reference letters of previous supervisors or professors, or names of references,
- a brief description of your research interests highlighting the links between your education/ training/experience and the thesis topic,

to:

- Renaud Marlet <renaud.marlet@enpc.fr>,
- Alexandre Boulch <alexandre.boulch@onera.fr>.

Some references

[Boulch 2013] Semantizing Complex 3D Scenes using Constrained Attribute Grammars, Alexandre Boulch, Simon Houllier, Renaud Marlet, Olivier Tournaire. Computer Graphics Forum, 2013, 32 (5), pp.33-42.

[Boulch 2014] Piecewise-Planar 3D Reconstruction with Edge and Corner Regularization, Alexandre Boulch, Martin De La Gorce, Renaud Marlet. Computer Graphics Forum, 2014, 33 (5), pp.55--64.

[Guney 2015] Displets: Resolving Stereo Ambiguities using Object Knowledge. Fatma Guney, Andreas Geiger, Computer Vision and Pattern Recognition (CVPR) 2015.

[Hana 2015] SynthCam3D: Semantic Understanding With Synthetic Indoor Scenes. Ankur Handa, Viorica Patraucean, Vijay Badrinarayanan, Simon Stent, Roberto Cipolla, CVPR 2015 Workshop.

[Monszpart 2015] RAPTER: Rebuilding Man-made Scenes with Regular Arrangements of Planes. Monszpart, Aron and Mellado, Nicolas and Brostow, Gabriel J and Mitra, Niloy J. Siggraph 2015.