PostDoc Position in geometry processing / computer vision

-

Reconstruction and approximation with low-poly 3D models

Context

Geometric modeling has become an indispensable component in the quest towards the 3D digitization of our world. The need for 3D models reconstructed from physical measurements is ubiquitous, from 3D printing to architectural design through reverse engineering and intelligent cities. In many applicative fields, only user-guided Computer-Aided Design (CAD) tools can deliver 3D models whose quality fulfills the requirements of practitioners. Indeed, when a human operator creates a CAD model with an interactive software such as AutoCAD, he leverages expert knowledge, learned from past experiences, on the nature of the object and its structure into geometric parts. However, these tools and their reliance on user interaction do not constitute a viable solution for processing big volumes of data: designing automatic reconstruction algorithms that produce CAD-quality models is a key scientific challenge. This problem is however difficult as, not only fidelity to input data is taken into account, in contrast to freeform geometry reconstruction problems [1]. Such models must also be concise, ie with a low number of polygonal facets, and must preserve the inherent structure of objects.

While existing methods in the field have made important progresses, the quality of results remains far behind user-guided CAD models. Methods typically operate by either simplifying dense surface meshes [2], learning Binary Space Partitioning trees [3] or assembling geometric primitives using Space Partitioning Data structures [4,5,6,7]. The latter solution relies upon the construction of a geometric data structure that decomposes the 3D space into relevant volumes (see Figure 1). This solution is particularly promising as the output models come with strong geometric guarantees, eg intersection-free and watertight surfaces.

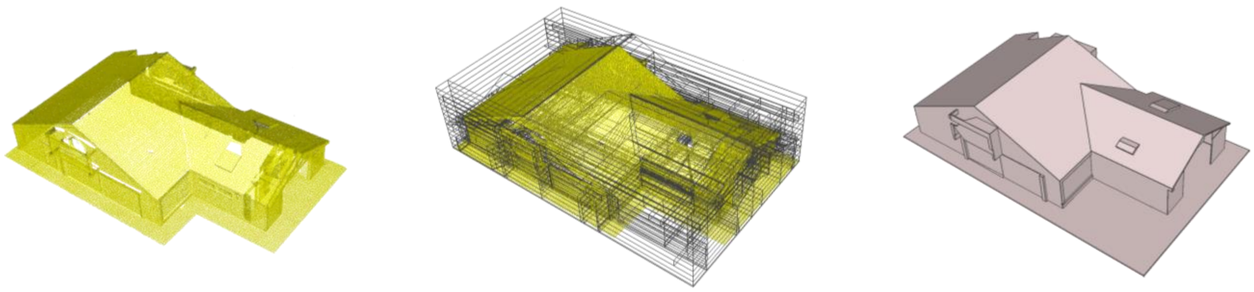

Figure 1 – Reconstruction of a low-poly 3D model (right) from a Laser scan of a building (left) by the Kinetic Shape Reconstruction algorithm [6]. A Space-Partitioning Data Structure under the form of a polyhedra partition (middle) is created to scaffold the observed object. Some facets of this partition are then selected to be part of the output model.

CENTRE DE RECHERCHE
SOPHIA ANTIPOLIS - MÉDITERRANÉE
2004 route des Lucioles - BP 93
06902 Sophia Antipolis Cedex
Tél. : +33 (0)4 92 38 77 77
Fax : +33 (0)4 92 38 77 65

www.inria.fr

Objectives
The main goal of the PostDoc is to develop efficient, robust and scalable methods for reconstructing and approximating objects and scenes with low-poly, CAD-styled, 3D models from data measurements, typically point clouds. Among the possible research directions to investigate, two seem to be particularly interesting:

Designing efficient space-partitioning data structures. Existing Space-Partitioning Data Structures are not fully satisfactory because they rely upon complex construction processes, eg Kinetic simulations [6], and often deliver imprecise 3D partitions whose volumes are not well-aligned with input data. The candidate will investigate how to design data structures easy to construct, ideally using an incremental process where geometric primitives are inserted one per one, as for Delaunay triangulations. It will be also interesting to study how to modify a 3D partition to better align it with the data. Besides basic operations such as the split of volumes, geometric regularities between volumes should be also encouraged.

Predicting occupancy accurately. Existing methods extract output models from 3D partitions in a very simple manner, typically using a voting scheme over the orientations of input point normals. The candidate will investigate how to compute more accurate occupancy predictions, in particular by using neural signed distance fields, and how to exploit them explicitly within an irregular polyhedral partition of the 3D space.

Keywords: Geometry Processing, Computer Vision, Surface Reconstruction, concise polygon mesh, Space-Partitioning Data Structure

Contact: Florent Lafarge (Florent.Lafarge@inria.fr) and Pierre Alliez (Pierre.Alliez@inria.fr)
Location: Titane project-team at Inria Sophia Antipolis, France

Duration: 1 year (with possibility of a 1-year extension)

Application deadline: July 22, 2022

Starting date: between October and December 2022

References
[1] Berger, Tagliasacchi, Seversky, Alliez, Guennebaud, Levine, Sharf, and Silva. A Survey of Surface Reconstruction from Point Clouds. Computer Graphics Forum 36 (1), 2017
[2] Cohen-Steiner, Alliez, and Desbrun. Variational shape approximation. In ACM SIGGRAPH, 2004
[3] Chen, Tagliasacchi, and Zhang. Bsp-net: Generating compact meshes via binary space partitioning. In CVPR, 2020
[4] Nan and Wonka. Polyfit: Polygonal surface reconstruction from point clouds. In ICCV, 2017
[5] Fang and Lafarge. Connect-and-Slice: an hybrid approach for reconstructing 3D objects. In CVPR, 2020
[6] Bauchet and Lafarge. Kinetic Shape Reconstruction. ACM Trans. on Graphics, Vol. 39(5), 2020
[7] Yu and Lafarge. Finding Good Configurations of Planar Primitives in Unorganized Point Clouds. In CVPR, 2022