Intership proposal

3D Point-cloud Structuring by Learning

Themes : computer science, computer graphics, shape analysis, point cloud, learning, CAD
Affiliation : IRIT UMR 5505, Université Paul Sabatier, Université Fédérale de Toulouse
Location : Rangueil, Toulouse, France
Research Group : STORM
Supervision : Nicloas Mellado (Nicolas.Mellado@irit.fr) and Thibault Lejemble (Thibault.Lejemble@irit.fr)

The internship will take place in the IRIT laboratory, on the Université Paul Sabatier Campus of Toulouse. The recruited intern will be a full member of the STORM research team, working with the other team members, PhD students and permanent researchers. He/she will participate to working groups, scientific seminars and other activities of our group. Experiments will be implemented in Radium, the 3D engine developed in the team.

Context

3D scanner and point data acquisition hardware are more and more used in the industry to capture CAD models (Fig 1). A wide range of applications exploit point-clouds, for instance retro engineering, automatic analysis of used part, or augmented reality for technical intervention.

Figure 1: A Go!Scan3D portable point cloud scanner

Objectives

In most practical geometry processing work-flows, acquired point-clouds are converted to polygonal meshes, a convenient representation for visualization, geometry processing and analysis. Polygonal meshes offer an explicit definition of the represented surfaces, and benefit from a wide range of analysis and processing techniques developed during the last decades. In the past years, approaches have been proposed to *structure* the geometry, for instance by extracting geometrical primitives and their relations [1, 2].

In practice, the conversion between point-clouds and meshes is a tedious process, where the surface is reconstructed from the sparse samples of the point-cloud. Many reconstruction techniques are available in the literature [3], all coming with different parameter sets, guaranties, and final results. Finding the optimal reconstruction technique for practical use case is not straightforward. In addition, reconstructing a point-cloud without knowing the structure of the described geometry may introduce artifacts or ambiguities penalizing further processing.

The goal of our project is to estimate structural properties of 3D shapes directly from point-clouds. During the internship, the student will use recent techniques developed in the team to extract

high-level geometrical structures in point-clouds (inspired by scale-space point-cloud analysis [4]), and evaluate their compatibility with state of the art supervised learning approaches. It is worth to mention that the lack of explicit surface definition and parametrization prevents to use recent deep learning techniques [5] for point-based shape analysis.

Student profile

- Master student in Computer Science or Applied Mathematics
- Strong programming skills
- Knowledge on supervised learning
- Basic knowledge on computational geometry and shape analysis
- Fluent English or French spoken

Contact

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References

[1] Yangyan Li, Xiaokun Wu, Yiorgos Chrysanthou, Andrei Sharf, Daniel Cohen-Or, and Niloy J. Mitra. Globfit: Consistently fitting primitives by discovering global relations. *ACM Transactions on Graphics*, 30(4):52:1–52:12, 2011.

[2] Aron Monszpart, Nicolas Mellado, Gabriel J. Brostow, and Niloy J. Mitra. RAPter: Rebuilding man-made scenes with regular arrangements of planes. *ACM Trans. Graph.*, 34(4):103:1–103:12, 2015.

[3] Matthew Berger, Andrea Tagliasacchi, Lee Seversky, Pierre Alliez, Gael Guennebaud, Joshua Levine, Andrei Sharf, and Claudio Silva. A Survey of Surface Reconstruction from Point Clouds. *Computer Graphics Forum*, page 27, 2016.

[4] Nicolas Mellado, Gaël Guennebaud, Pascal Barla, Patrick Reuter, and Christophe Schlick. Growing least squares for the analysis of manifolds in scale-space. *Comp. Graph. Forum*, 31(5):1691–1701, August 2012.

[5] Michael Bronstein, Evangelos Kalogerakis, Emanuele Rodola, Jonathan Masci, and Davide Boscaini. Deep Learning for Shape Analysis. In Augusto Sousa and Kadi Bouatouch, editors, *EG 2016 - Tutorials*. The Eurographics Association, 2016.