A point-cloud normal surface estimation methods comparison

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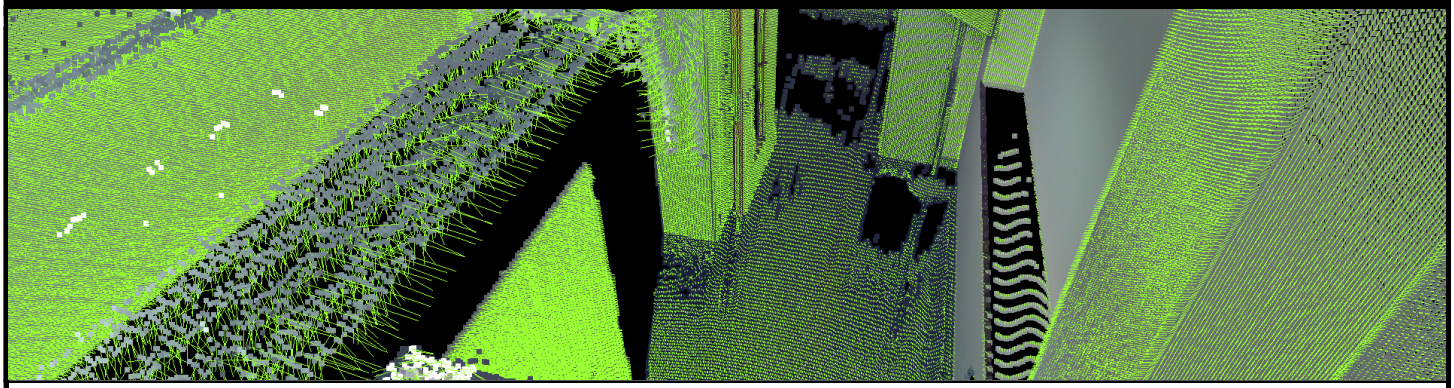

Introduction

Surface normal estimation is a relevant step in many graphics/geometry processing stages of different applications from rendering point-cloud data obtained directly from a 3D scanner to other more complex applications like surface reconstruction. In the last years, many related approaches have been proposed to solve this problem, some of them are robust to noise and consider the presence of sharp features like edges and corners.

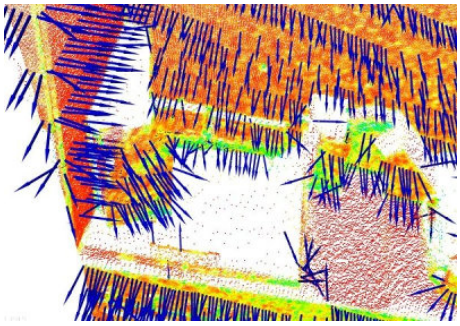

Figure 1: PCL: point-cloud normal surface estimation (pointclouds.org).

The earliest approaches compute the k-nearest neighborhood and use PCA or Jet Fitting to estimate the normal for each point. Figure 1 shows a point-cloud surface normal estimation. The subsequent processing steps include handling the consistent orientation of these point normals, handling noise, and sharp features [1, 2]. Recent work proposes to use deep learning to improve the estimation of point-cloud normals using different CNN approaches [3, 4].

Assignment

This project has the aim to explore and compare different methods to estimate surface normals of an unstructured point-cloud. Some methods are already included in C++ libraries like CGAL (cgal.org) and PCL (pointclouds.org). The comparison could be done by quantitative analysis (Figure 2) and from the visual results of the rendered views. Some tentative methods to consider for this project are listed in the references. The comparison will include your own implemented methods as well as the methods implemented in PCL and CGAL libraries.

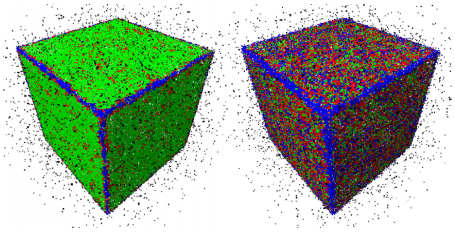

Figure 2: Quantitative analysis: angle deviation and error [2].

Requirements

Interest and willingness to learn about computer graphics and computational geometry. This project requires C++ programming experience, and prior knowledge of OpenGL is recommended.

Work Load

- 30% Theory
- 50% Implementation
- 20% Test

Project Type

This project can be defined for the requirements of a Bachelor or Master thesis, or possibly for a Master project. The goals and tasks will be adjusted accordingly.

Supervision

- Prof. Dr. Renato Pajarola
- Luciano A. Romero Calla (assistant)

Contact

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References

[1] Aravind Kalaiah and Amitabh Varshney. Modeling and rendering points with local geometry. *IEEE Transactions on Visualization and Computer Graphics*, 9(1):30–42, January-March 2003.

[2] Claudio Mura, Gregory Wyss, and Renato Pajarola. Robust normal estimation in unstructured 3D point clouds by selective normal space exploration. *The Visual Computer*, 34(6-8):961–971, June 2018.

[3] Alexandre Boulch and Renaud Marlet. Deep learning for robust normal estimation in unstructured point clouds. In *Proceedings Eurographics Symposium on Geometry Processing*, 2016.

[4] Y. Ben-Shabat, M. Lindenbaum, and A. Fischer. Nesti-net: Normal estimation for unstructured 3d point clouds using convolutional neural networks. In *2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 10104–10112, 2019.

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