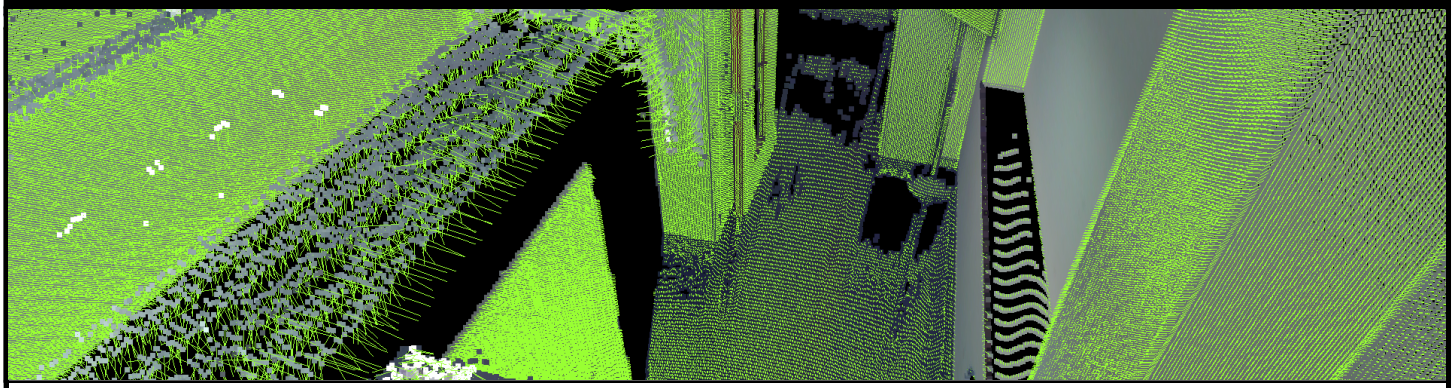
Comparison study of point-cloud surface normals estimation methods

University of Zurich[UZH]



Introduction

Surface normal estimation is relevant 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. Many related approaches have existed to solve this problem. Some of them are robust to noise and consider the presence of sharp features like edges and corners.

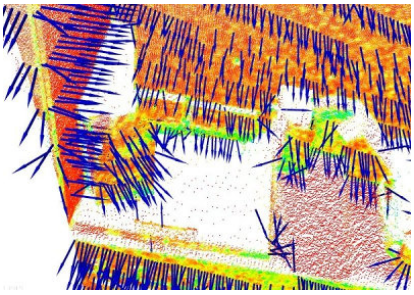


Figure 1: Point-cloud normal surface estimation (pointclouds.org).

The earliest approaches compute the k-nearest neighborhood and use PCA or Jet Fitting to estimate the normal for each point. But, this project will explore deep learning-based methods for estimating point cloud normals.

Assignment

This project explores and compares different deep learning-based methods to estimate the surface normals of unstructured point clouds and the classic ones. The comparison could be made by quantitative analysis and from the visible results of the rendered views. Some tentative methods to consider for this project are in the references.

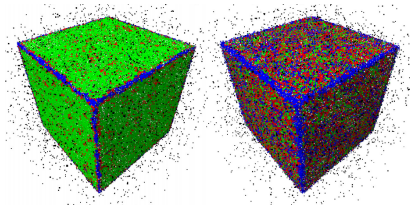


Figure 2: Quantitative analysis: angle deviation and error [1].

Tasks

The main proposed tasks in this project are:

- Review state-of-the-art and understand the main concepts for point cloud deep learning networks.
- Select papers from the state-of-the-art with available code and run some initial tests.
- Select datasets to test and compare the networks besides the usual ones in their papers.
- Visualise the models, their normals, and the error for the computed normals.
- Use generate point clouds from scenes to test and train.
- Use the VMML scan rooms dataset to test the networks.
- Report the comparison in terms of accuracy and performance.

Requirements

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

Work Load

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

Project Type

This project is a Master's thesis. The goals and tasks can be adjusted.

Supervision

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

Contact

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References

[1] 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.

[2] Haoyi Xiu, Xin Liu, Weimin Wang, Kyoung-Sook Kim, and Masashi Matsuoka. Msecnet: Accurate and robust normal estimation for 3d point clouds by multi-scale edge conditioning. *arXiv:2308.02237*, 2023.

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