ToFNest: Efficient normal estimation for ToF depth cameras

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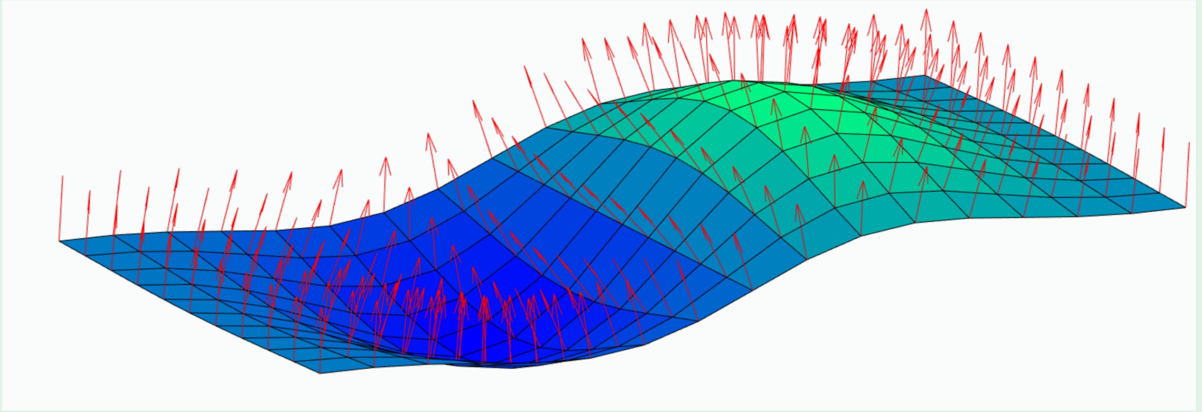
Context

Main motivation

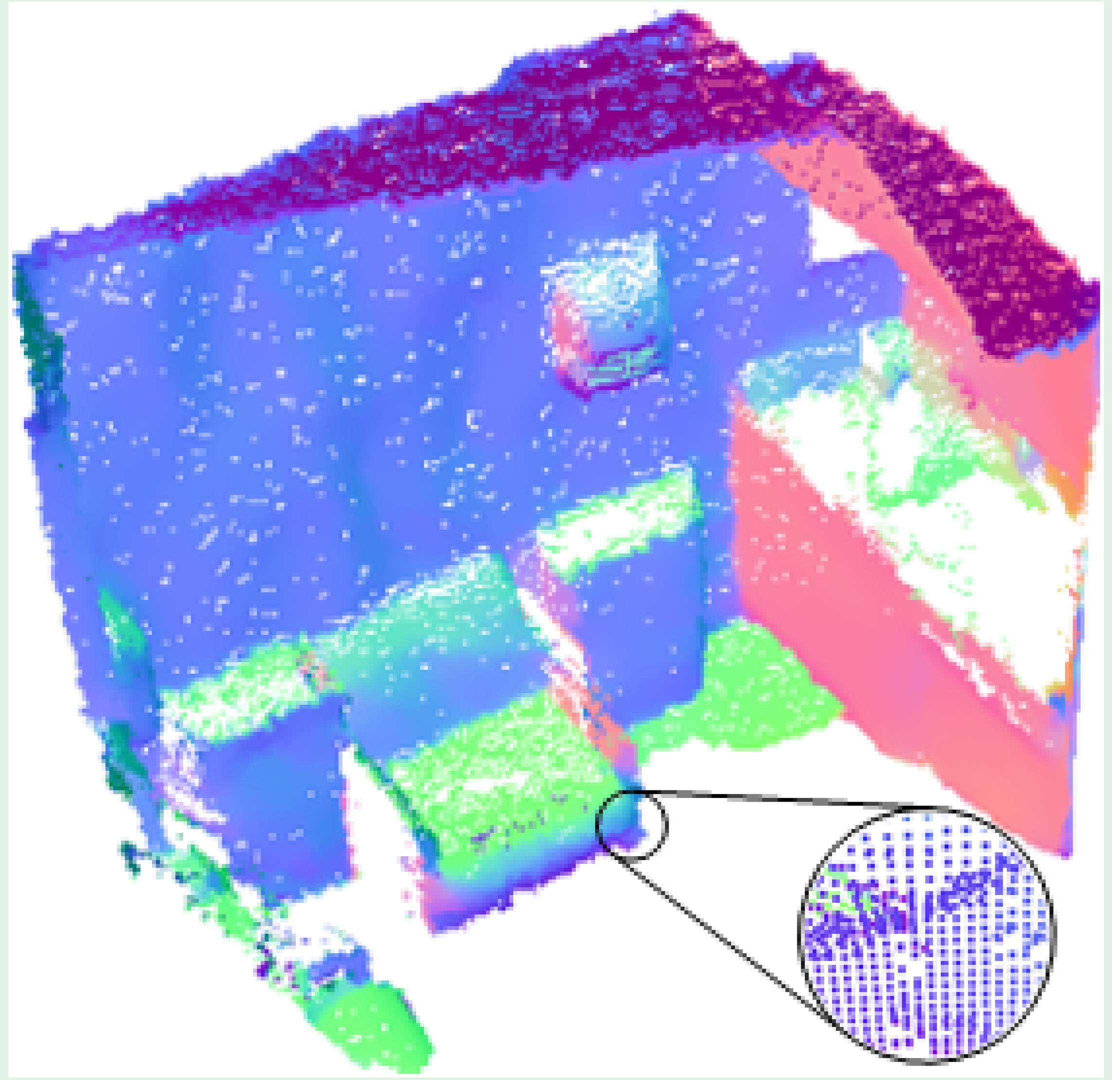
- Point Cloud Features - Normals
- Visual Effects
- Speed / Robustness
- Embedded performance



Normal decoding into RGB

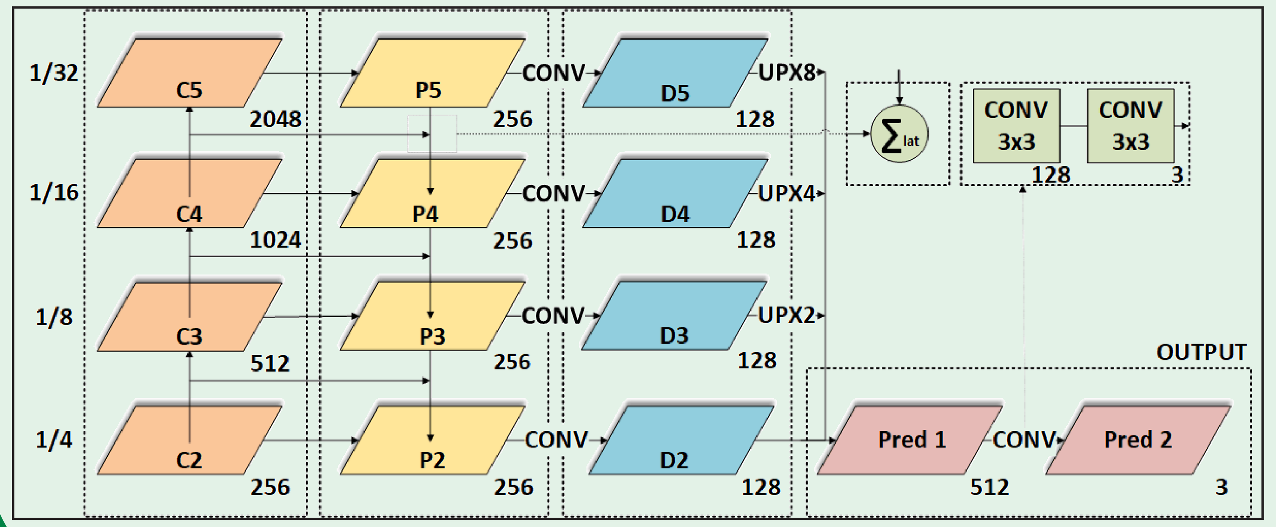
Used for

- X,Y,Z koordinates -> RGB values
- 2D data representation
- low resource usage (embedded devices, GPUs)

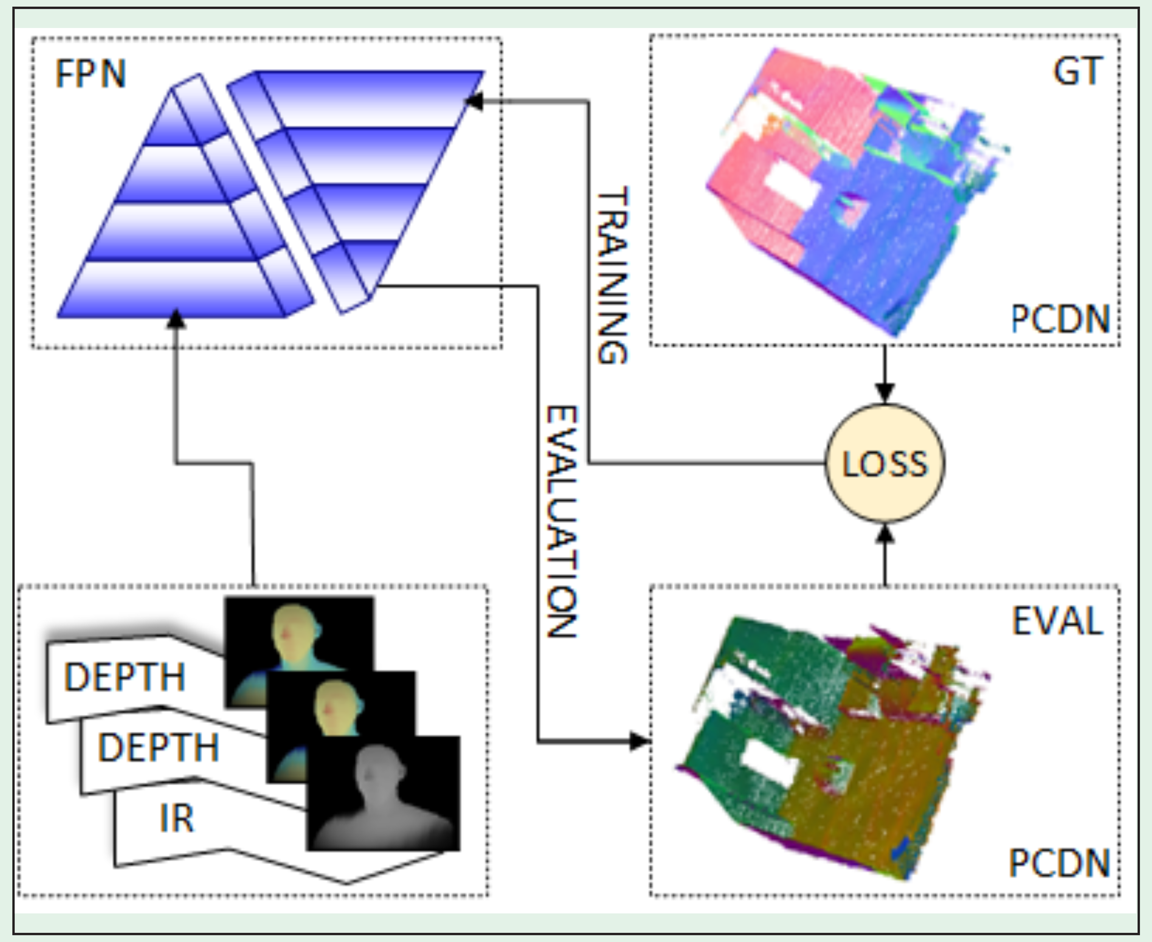


Architecture

To achieve multiscale normal estimation, a **Feature Pyramid Network** (FPN) [4] was used.
In the image below you can see the layers (top-down, bottom-up, lateral connections):

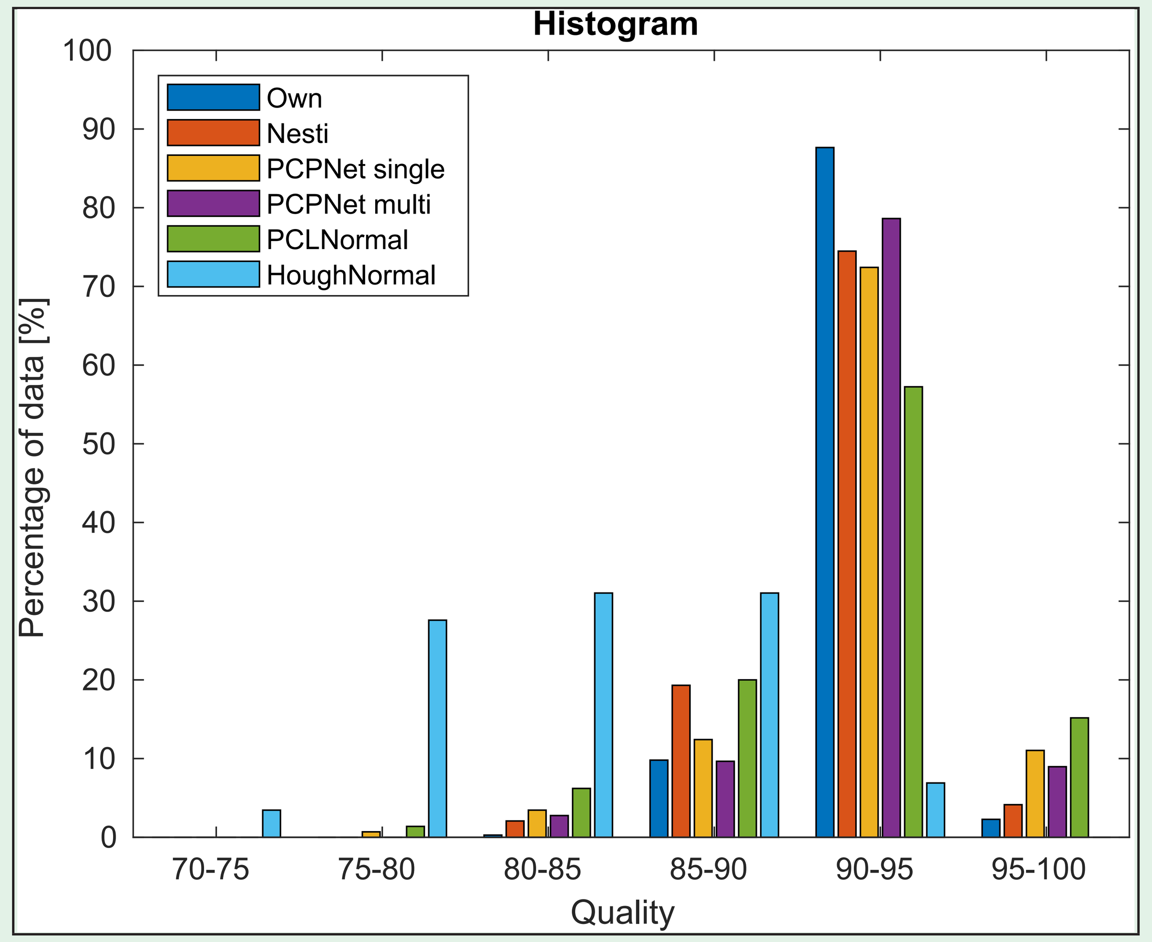


The whole architecture:

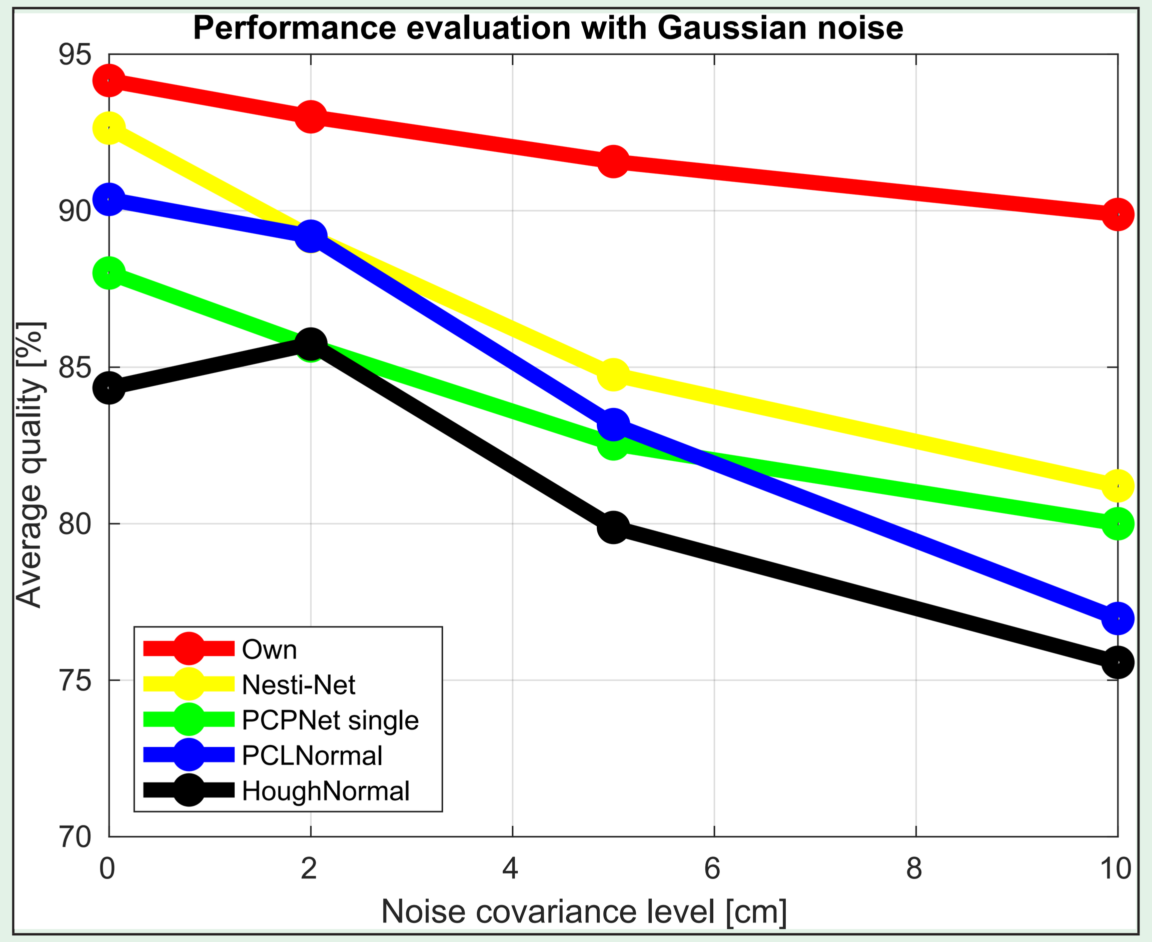


Comparison results

The distribution of data on quality percentage:



The robustness of the method against noise:



Average quality and runtime comparison between the different methods:

	Own	Nesti-Net [1]	PCPNet ss [3]	PCPNet ms [3]	PCL [5]	Hough [2]
Avg. hist. [%]	0.922	0.913	0.911	**0.923**	0.914	0.829
Avg. runtime [*s*]	**0.015**	1200	234	596	7.09	2.7

Future work

- Improvement against sparse data (LiDAR)
- Separate denoising module
- Implementation through Variational Autoencoder architecture
- Make the method more independent of camera extrinsic -> better cross-validation

References

More details in: *Szilárd Molnár, Benjamin Kelényi, and Levente Tamás. Tofnest: Efficient normal estimation for time-of-flight depth cameras. InProceedings of the IEEE/CVF International Conference on Computer Vision (ICCV) Workshops, pages 1791–1798, October 2021.*

[1] Yizhak Ben-Shabat, Michael Lindenbaum, and Anath Fischer. Nesti-net: Normal estimation for unstructured 3d point clouds using convolutional neural networks. In *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 06 2019.

[2] Alexandre Boulch and Renaud Marlet. Fast and robust normal estimation for point clouds with sharp features. *Computer Graphics Forum*, 31:1765–1774, 08 2012.

[3] P. Guerrero, Yanir Kleiman, M. Ovsjanikov, and N. Mitra. Pcpnet learning local shape properties from raw point clouds. *Computer Graphics Forum*, 37, 2018.

[4] T. Lin, P. Dollár, R. Girshick, K. He, B. Hariharan, and S. Belongie. Feature pyramid networks for object detection. In *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 936–944, 2017.

[5] Radu Bogdan Rusu and Steve Cousins. 3D is here: Point Cloud Library (PCL). In *IEEE International Conference on Robotics and Automation (ICRA)*, Shanghai, China, 05 2011.

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