Depth Map Denoisng & Point Cloud Interpolation

Depth maps are obtained from sensors such as lidar and stereo vision and usually converted to point cloud later. Depth measurements can be corrupted and one way to denoise the depth to impose a prior on spatial correlation. Just like 2d images, depth should vary slowly for the most part except for the edges. Point clouds may look dense from certain view angle, but it is very coarse in the 3d space. Even when multiple captures were put together, realizing smooth surfaces require significant number of sampling points, which is why interpolation can become very useful.

For my project, I want to investigate works in denoising and inpainting of 3d data using model-based or hybrid methods (not interested in purely data-driven approach), implement some of them, and test them with 3d data. Stanley Chan has recently submitted a paper on this topic to arxiv [1], which I think it would something interesting to take a deeper look. Similar work has also been done by another author in 2015 [2].

I am thinking of focusing on multi-view depth maps since point clouds generated from single view are usually too coarse to be interpolated. I think it would be interesting if I can build a likelihood model where each point has high ambiguity in one direction (depth) and use a regularizer to jointly solve denoising and interpolation.

I am planning to use depth maps / point cloud data from online and from my phone (my phone has lidar and I have used my phone to capture 3d maps in the past). I can also generate synthetic depth maps from point cloud data using library such as open3d for python,. which I am planning to use for this project.

[1] X. Zhang, G. Cheung, J. Pang, Y. Sanghvi, Y., A. Gnanasambandam., & S.H. Chan. ” Graph-Based Depth Denoising & Dequantization for Point Cloud Enhancement,” *ArXiv, abs/2111.04946*, Oct. 2022.

[2] P. Wan, G. Cheung, P. A. Chou, D. Florencio, C. Zhang and O. C. Au, "Precision Enhancement of 3-D Surfaces from Compressed Multiview Depth Maps," in IEEE Signal Processing Letters, vol. 22, no. 10, pp. 1676-1680, Oct. 2015, doi: 10.1109/LSP.2015.2423372.