Organized Point Clouds

- Point clouds that resemble an matrix like structure, where data is split into rows and columns;
- Adjacent points (pixels) relationship is known, allowing more efficient nearest neighbor operations and lowering the costs of certain algorithms.

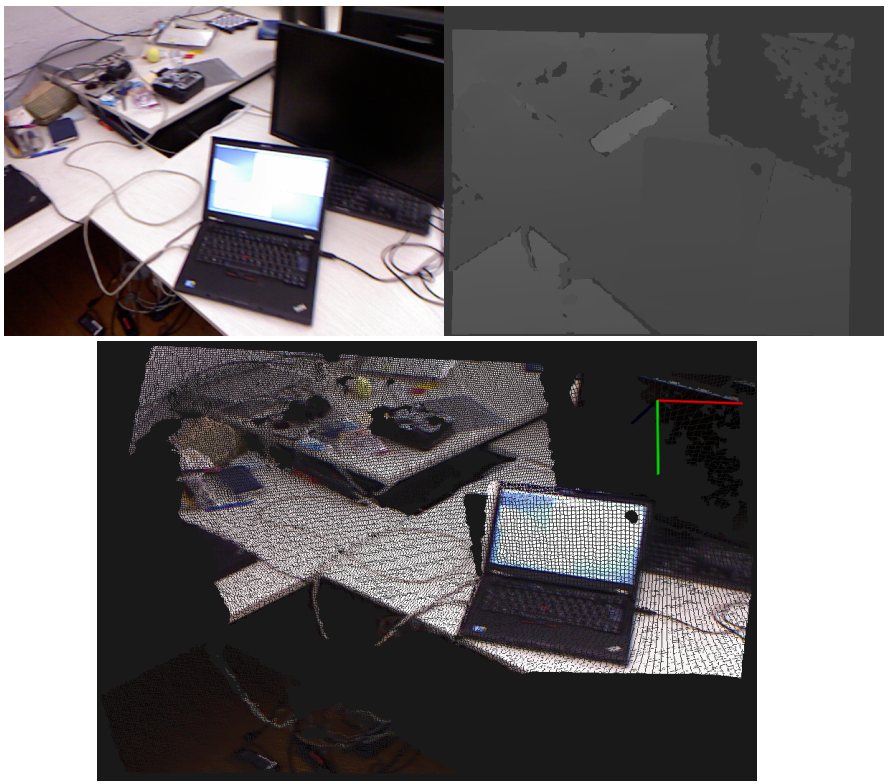
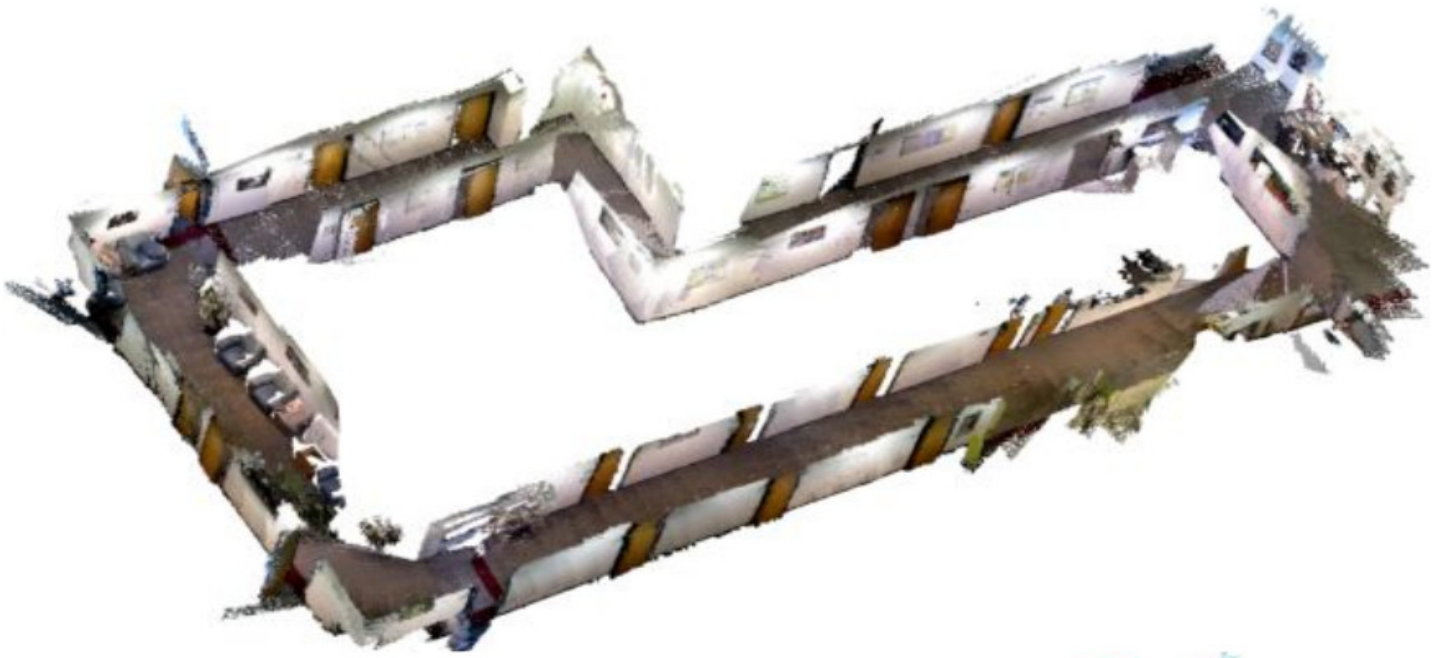


Figure : RGB, depth and organized point cloud.

Unorganized Point Clouds

- Registration with other point clouds, reconstruction through mesh model conversion etc.

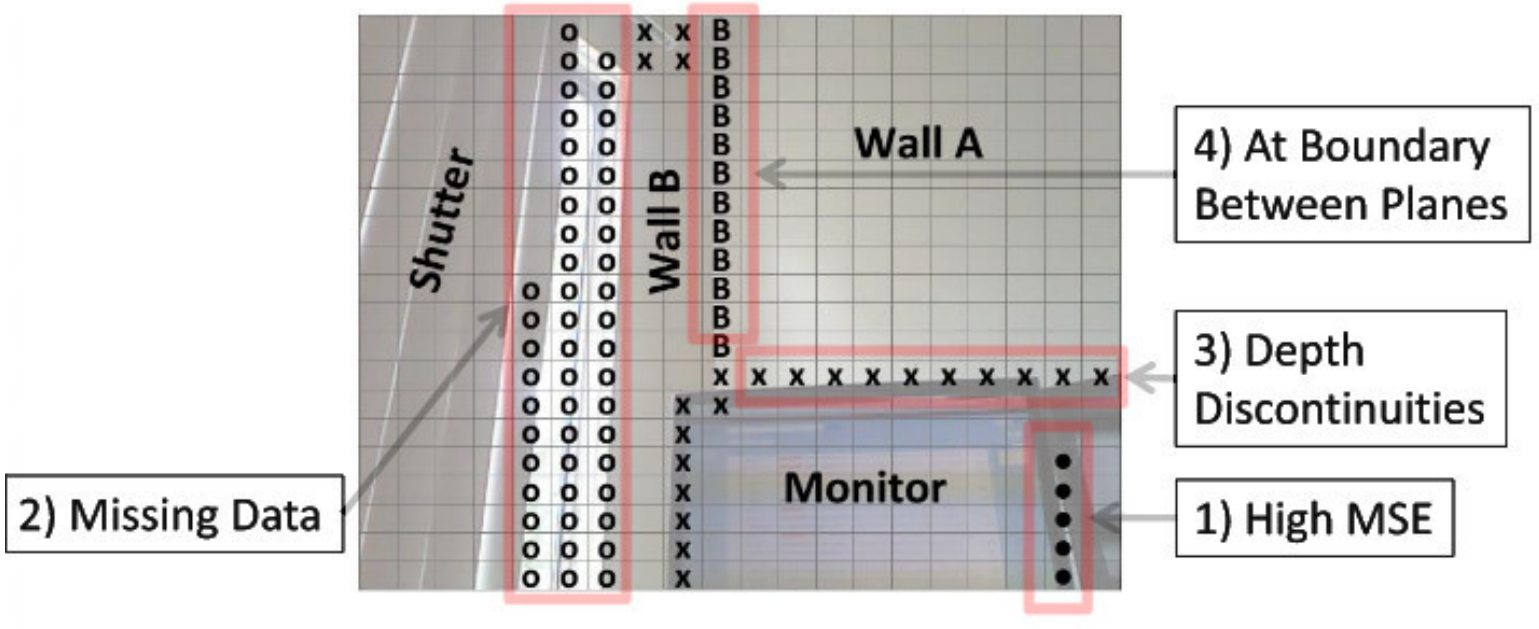


How I Ended Up Here

- Reading through some 2013+ SLAM proposals, place recognition or mapping-specific works that make use of depth/point cloud features:
  - Keyframe-based Dense Planar SLAM, Ming et al. - ICRA 2017;
  - CPA-SLAM: Consistent plane-model alignment for direct RGB-D SLAM, Lingnin et al. - ICRA 2016;
  - Place recognition based on matching of planar surfaces and line segments, Cupec et al. - IJRR 2015;
  - Fast place recognition with plane-based maps, Fernández-Moral et al. - ICRA 2013;
  - Some object/semantic or keypoint-based works, and skipping through lots of BoW and CNN stuff.

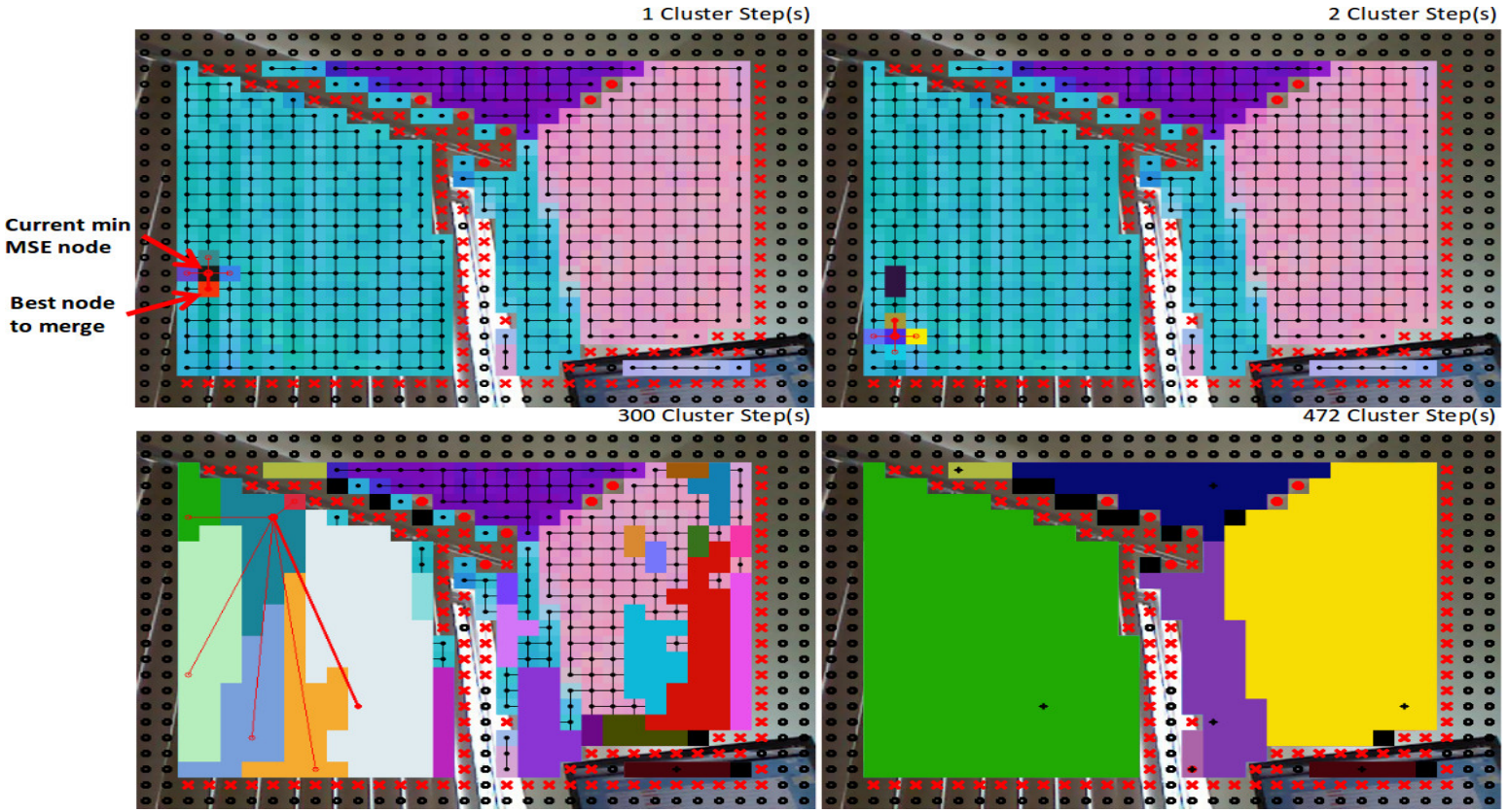
Current Planar Surface Segmentation Step

- Fast Plane Extraction in Organized Point Clouds Using Agglomerative Hierarchical Clustering, Feng et al. - ICRA 2014;
- Build a graph by dividing a point cloud into several uniform-sized non-overlapped regions:



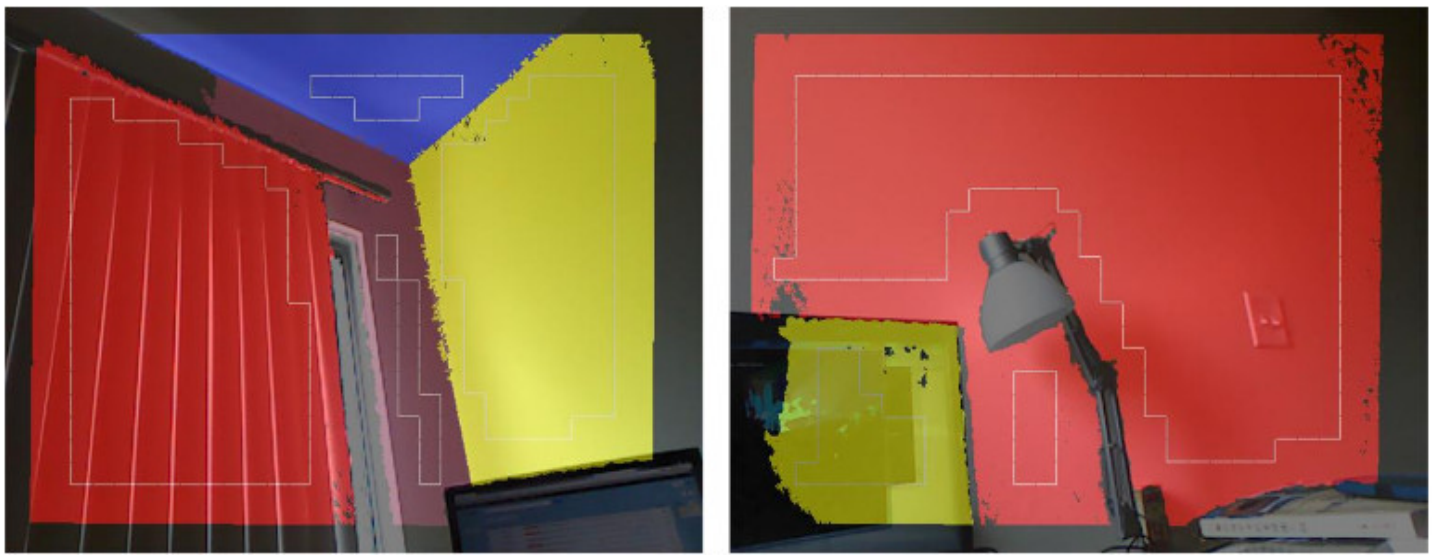
Current Planar Surface Segmentation Step

- Find the region with min. plane fitting mean squared error and merge it (edge contraction) with one neighbor such that merge results in the minimum plane fitting MSE:



Current Planar Surface Segmentation Step

- Refine boundaries of clustered regions with pixel-wise region-growing (only boundary blocks and points):

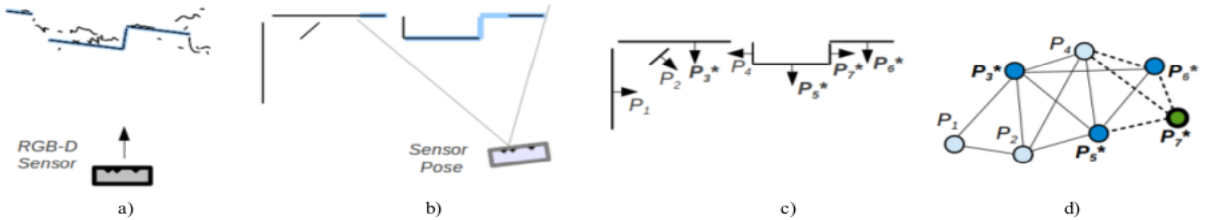


Previous Planar Surface Segmentation Step

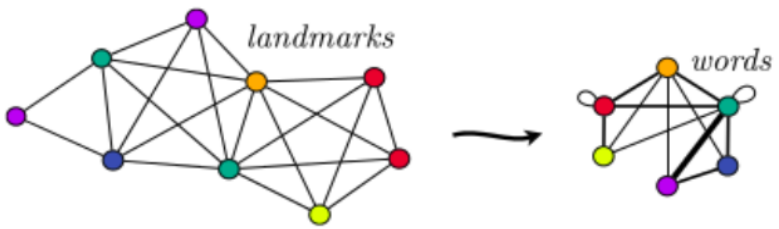
- Efficient Organized Point Cloud Segmentation with Connected Components, Trevor et al. - ICRA 2013 Workshop:
  - Compute per point normal using Integral Image Normal Estimation (Holzer et al 2012) method;
  - Partition into regions with labeled points, attempting to merge with different labeled neighbors;
  - Detect surfaces with smoothly changing surface normals, within threshold;
  - Plane fitting using least squares for each region with min. inliers;
  - Filter regions with exceeding max. threshold curvature.

Unsure How to Proceed..

- Fast place recognition with plane-based maps, Fernández-Moral et al. - ICRA 2013;



- Location Graphs for Visual Place Recognition, Stumm et al. - ICRA 2016;



- Searching for more alternatives and/or new ideas.

Unrelated, but important nonetheless

- Large-Scale 3D Scene Reconstruction with Hilbert Maps, Guizilini and Ramos - IROS 2016:
  - HM - Represent input space at an arbitrary resolution while capturing statistical relationships between measurements;
  - LARD-HM - Localized automatic relevance determination, a new method for the automatic selection of feature coordinate locations (vs OctoMap);
  - Experiments performed on a 8x2.50GHz notebook with OpenMP parallelization (avg. query time 849ms);
- Unsupervised Feature Learning for 3D Scene Reconstruction with Occupancy Maps, Guizilini and Ramos - AAAI 2017:
  - PS-HM - Segment planar surfaces based on raw unorganized point cloud data aiming a compact representation of HM (vs LARD-HM, OctoMap).