ROS-Industrial Advanced Developer's Training Class

July 2023

Southwest Research Institute

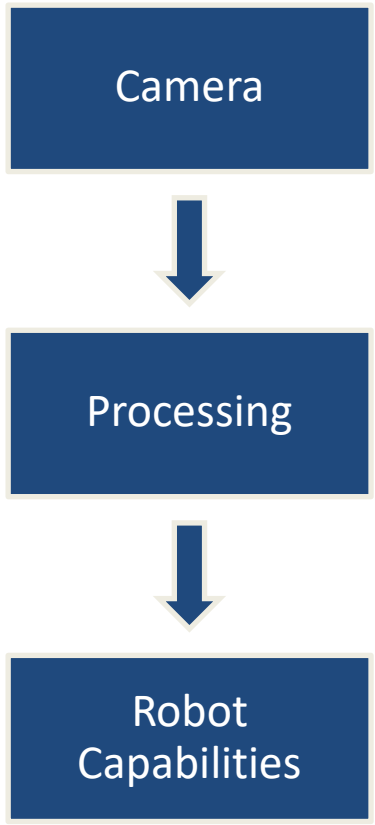
Advanced Topic:

Building a Perception Pipeline

Southwest Research Institute

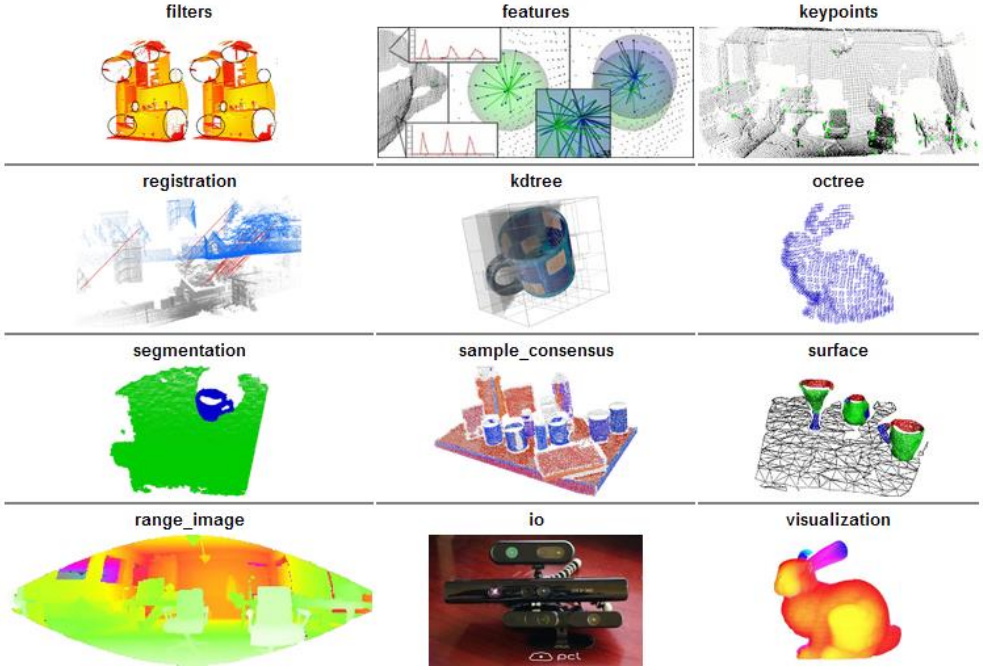
Perception Processing Pipeline

- Goal: Gain knowledge from sensor data
- Process data in order to
  - Improve data quality -> filter noise
  - Enhance succeeding processing steps -> reduce amount of data
  - Create a consistent environment model -> Combine data from different view points
  - Simplify detection problem -> segment interesting regions
  - Gain knowledge about environment -> classify surfaces



Perception Libraries (PCL)

- Point Cloud Library (PCL) - https://pcl.readthedocs.io/projects/tutorials/en/latest/
- Documentation - http://pointclouds.org/documentation/
  - Focused on 3D Range(Colorized) data



Perception Pipeline

Overall Process

- 3D Camera
- Processing
- Robot Capabilities

Perception Process

- Obtain PointCloud
- Convert PointCloud ROS->PCL
- Filter PointCloud
- Convert PointCloud PCL->ROS
- Publish PointCloud
- Broadcast Transform*

PCL Methods

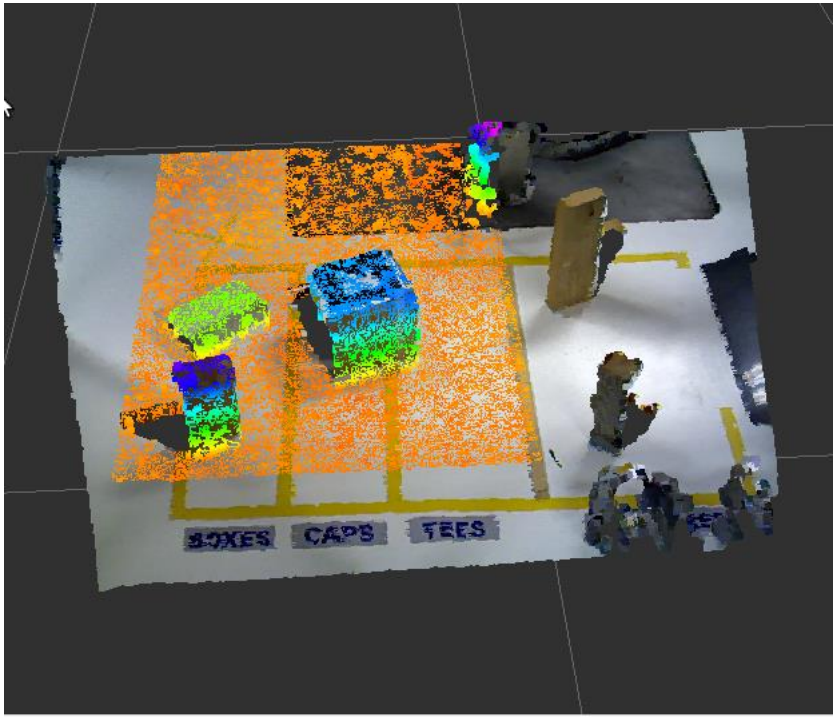
- Voxel Grid
- PassThrough
- RANSAC Plane Segmentation
- Others...

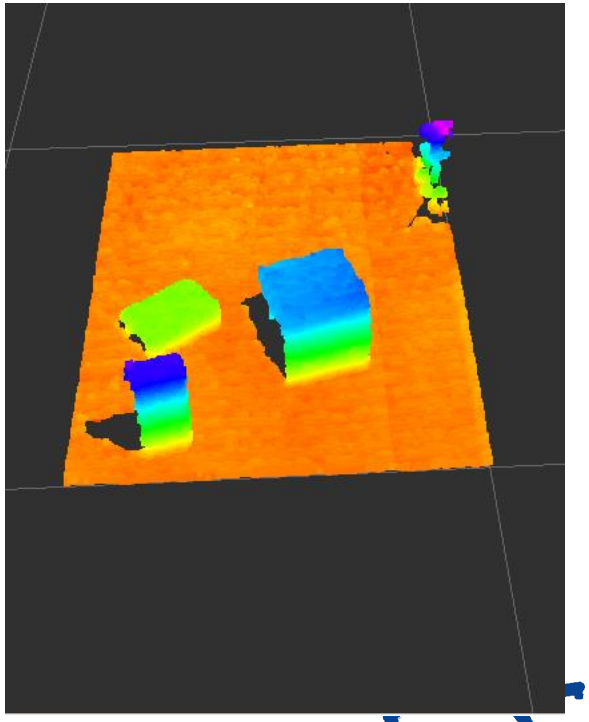
Voxel Grid

- Creates a 3D voxel grid over the input point cloud data
- In each voxel (i.e., 3D box), all the points present will be approximated (i.e., downsampled) with their centroid
- https://pcl.readthedocs.io/projects/tutorials/en/latest/voxel_grid.html

PassThrough

- Cut off values that are either inside or outside a given user range
- https://pcl.readthedocs.io/projects/tutorials/en/latest/passthrough.html





Plane Segmentation - RANSAC

- “RANdom SAmple Consensus” (RANSAC), and it is an iterative method that is used to estimate parameters of a mathematical model from a set of data containing outliers
- https://pcl.readthedocs.io/projects/tutorials/en/latest/random_sample_consensus.html

Plane model:

ax+by+cz+d=0

Plane Seg. – Extract Indices

- Find all the points within a point cloud that support a plane model

  https://pcl.readthedocs.io/projects/tutorials/en/latest/planar_segmentation.html

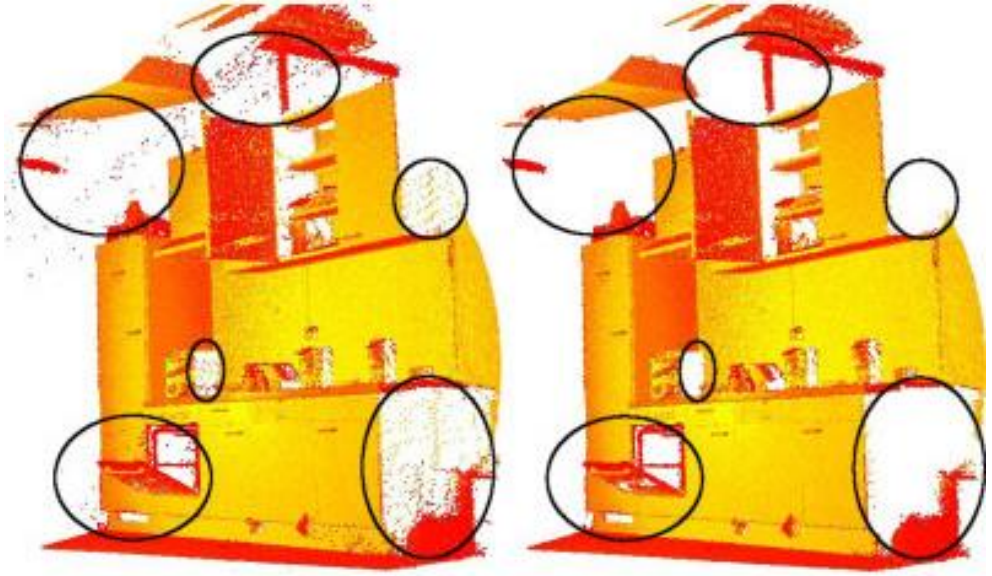
Other – Clusters

- Euclidean Cluster Extraction - A clustering method needs to divide an unorganized point cloud model into smaller parts
- https://pcl.readthedocs.io/en/latest/cluster_extraction.html

http://plasmodic.github.io/ecto_pcl/examples/colorize_clusters.html

Other – SOR

- Statistical Outlier Removal - Remove noisy measurements, e.g. outliers, from a point cloud dataset using statistical analysis techniques
- https://pcl.readthedocs.io/projects/tutorials/en/latest/statistical_outlier.html

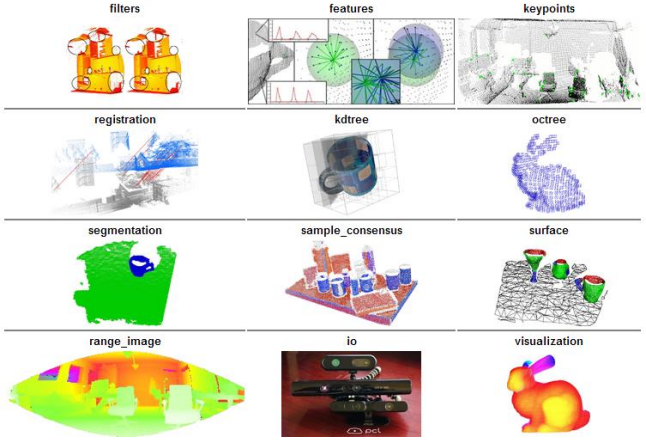


Other

- CropBox
- Segmentation - Region Growing, Min-Cut Based, Cylinder Model
- Clustering - Conditional Euclidean

Even more:

- Features
- Recognition
- Registration…



- https://pcl.readthedocs.io/projects/tutorials/en/latest/

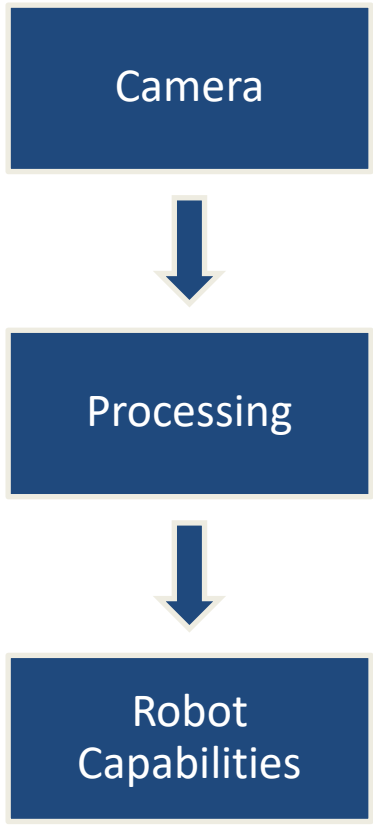
Exercise 5.0

- Exercise 5.0 - https://industrial-training-master.readthedocs.io/en/humble/_source/session5/Building-a-Perception-Pipeline.html

SIMPLE PCL INTERFACE FOR PYTHON

Simple PCL interface for python

- Goal: Create a ROS python node that uses PCL to process point cloud data
- Objectives
  - Create a python package
  - Call a service from python to filter a point cloud
  - Apply multiple filtering operations to a point cloud



Exercise 5.1

- Exercise 5.1 - https://industrial-training-master.readthedocs.io/en/humble/_source/session5/Simple-PCL-Interface-for-Python.html