



ROS-Industrial Advanced Developer's Training Class

July 2023

Southwest Research Institute





Advanced Topic:

Building a Perception Pipeline

Southwest Research Institute

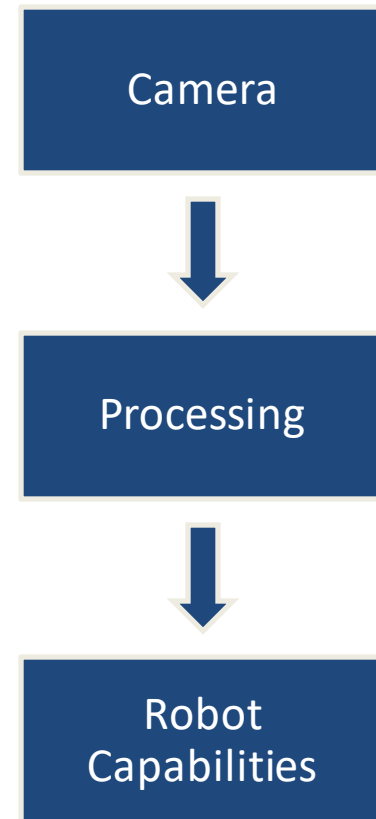




Perception Processing Pipeline



- 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

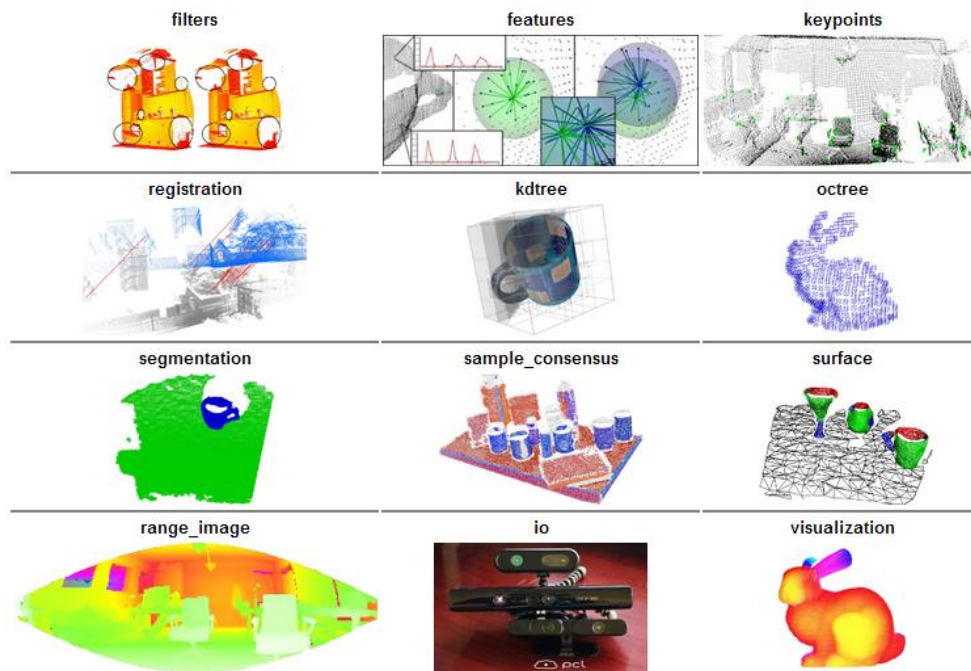




Perception Libraries (PCL)

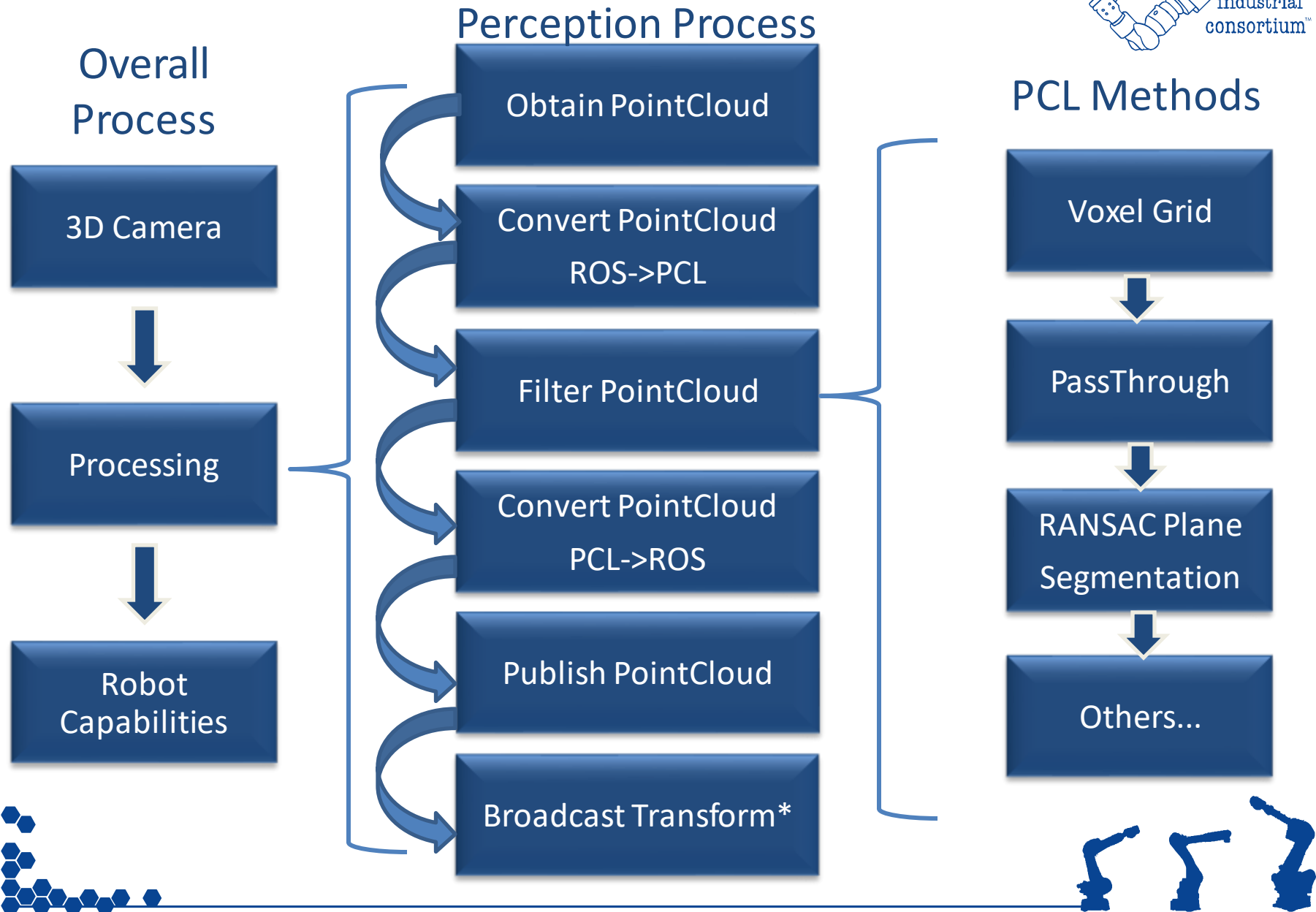


- Point Cloud Library (PCL) - <https://pcl.readthedocs.io/projects/tutorials/en/latest/>
- Documentation - <http://pointclouds.org/documentation/>
 - Focused on 3D Range(Colorized) data





Perception Pipeline





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



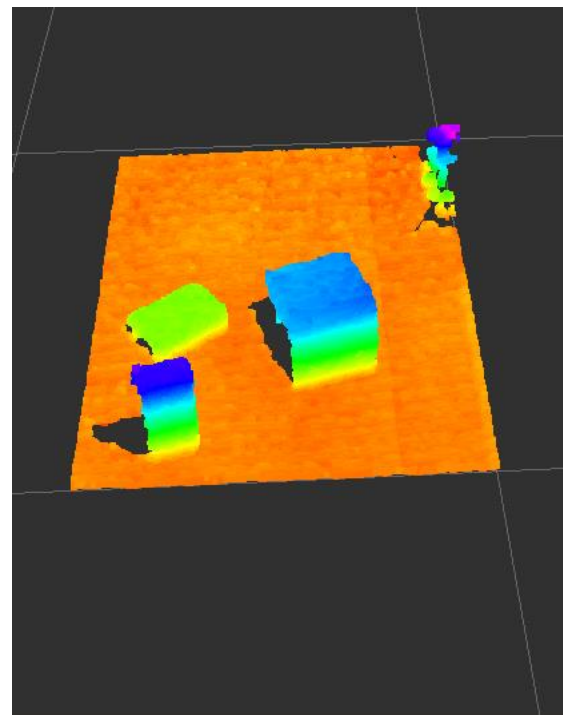
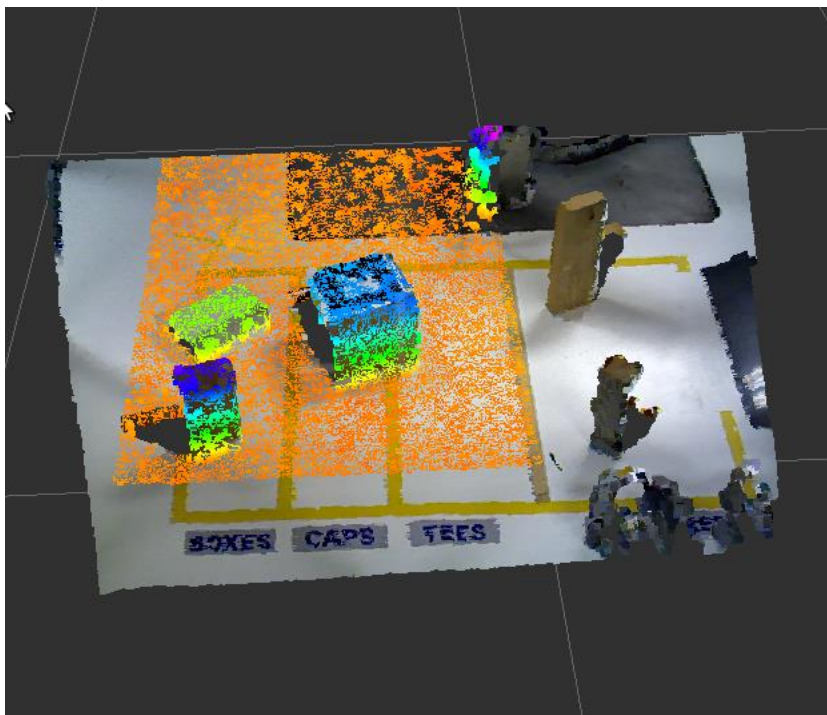
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PassThrough

- 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

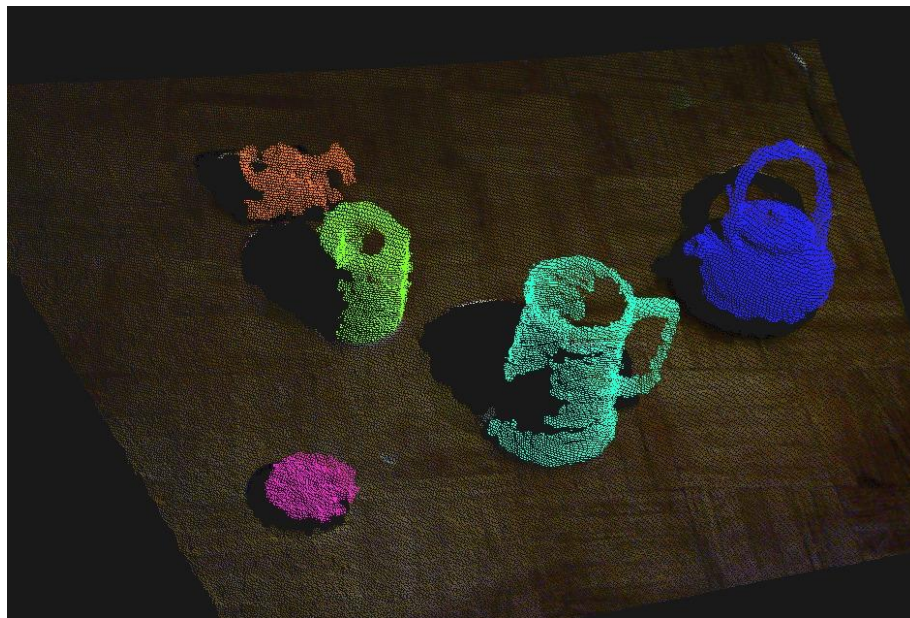
https://pcl.readthedocs.io/projects/tutorials/en/latest/planar_segmentation.html





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



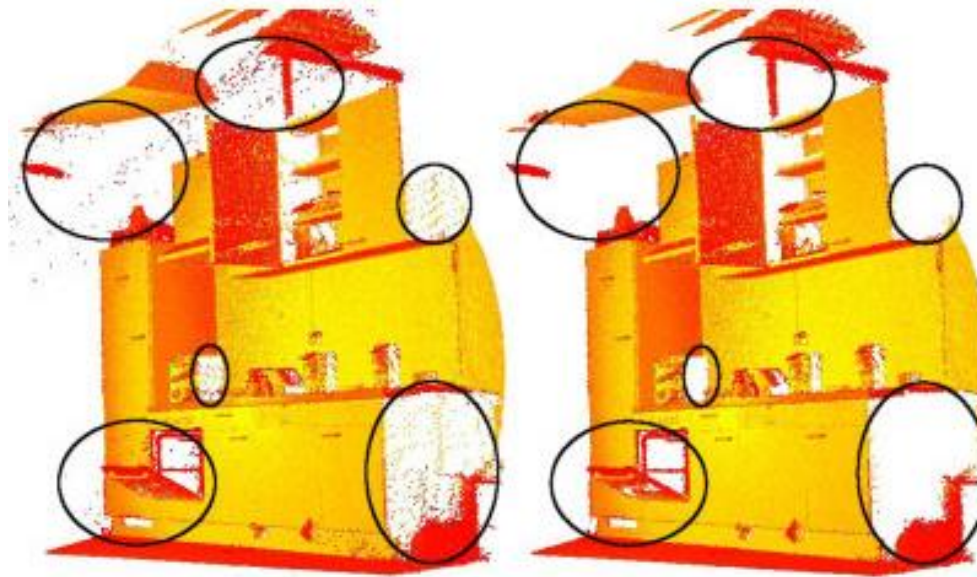
http://plasmodic.github.io/ecto_pcl/examples/colorize_clusters.html

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- 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

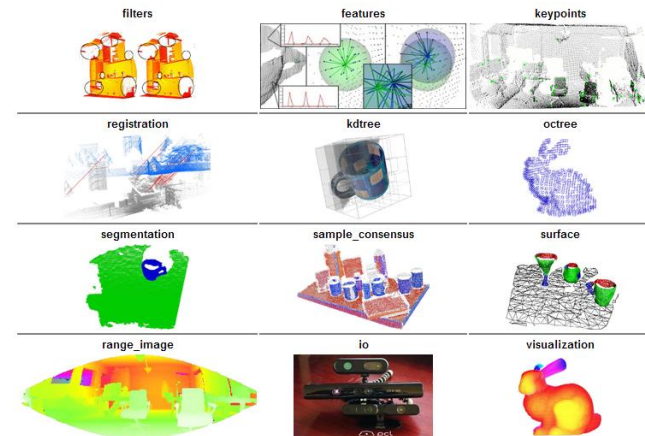




- CropBox
- Segmentation - Region Growing, Min-Cut Based, Cylinder Model
- Clustering - Conditional Euclidean

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

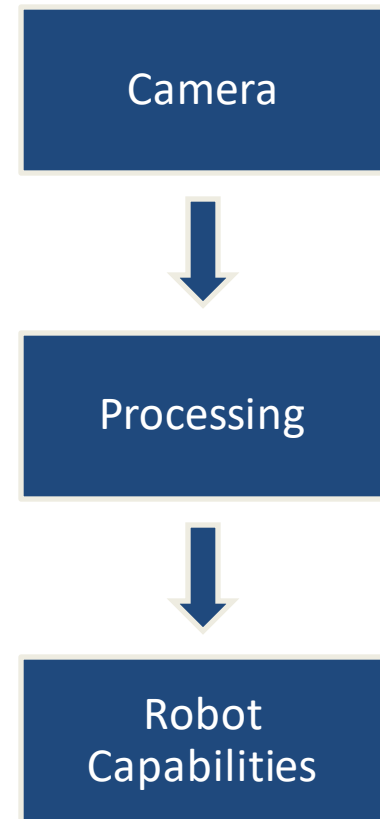




Simple PCL interface for python



- 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 5.3 - <https://industrial-training-master.readthedocs.io/en/humble/source/session5/Simple-PCL-Interface-for-Python.html>

