
Point Cloud Library

Release 0.0

Jul 07, 2021

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The following links describe a set of basic PCL tutorials. Please note that their source codes may already be provided as part of the PCL regular releases, so check there before you start copy & pasting the code. The list of tutorials below is automatically generated from reST files located in our git repository.



Note: Before you start reading, please make sure that you go through the higher-level overview documentation at <http://www.pointclouds.org/documentation/>, under **Getting Started**. Thank you.

As always, we would be happy to hear your comments and receive your contributions on any tutorial.



- walkthrough

	 <p>Title: PCL Functionality Walkthrough Author: <i>Razvan G. Mihalnyi</i> Compatibility: > PCL 1.6 Takes the reader through all of the PCL modules and offers basic explanations on their functionalities.</p>
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- basic_structures

	 <p>Title: Getting Started / Basic Structures Author: <i>Radu B. Rusu</i> Compatibility: > PCL 1.0 Presents the basic data structures in PCL and discusses their usage with a simple code example.</p>
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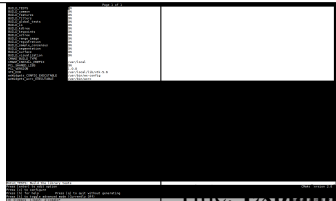
- using_pcl_pcl_config

	 <p>Title: Using PCL in your own project Author: <i>Nizar Sallem</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to link your own project to PCL using cmake.</p>
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- `compiling_pcl_posix`

	 <p>Title: Compiling PCL from source on POSIX compliant systems Author: <i>Victor Lamoine</i> Compatibility: > PCL 1.0 In this tutorial, we will explain how to compile PCL from sources on POSIX/Unix systems.</p>
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- `building_pcl`

	<p>Title: Configuring PCL's cmake options Author: <i>Nizar Sallem</i> Compatibility: > PCL 1.0 In this tutorial, we will explain the basic PCL cmake options, and ways to tweak them to fit your project.</p>
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- `compiling_pcl_dependencies_windows`

	<p>Title: Compiling PCL's dependencies from source on Windows Authors: <i>Alessio Placitelli</i> and <i>Mourad Boufarguine</i> Compatibility: > PCL 1.0 In this tutorial, we will explain how to compile PCL's 3rd party dependencies from source on Microsoft Windows.</p>
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- `compiling_pcl_windows`



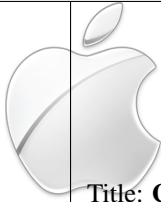
Title: Compiling PCL on Windows

Author: *Mourad Boufarguine*

Compatibility: > PCL 1.0

In this tutorial, we will explain how to compile PCL on Microsoft Windows.

- `compiling_pcl_macosx`



Title: Compiling PCL and its dependencies from MacPorts and source on Mac OS X

Author: *Justin Rosen*

Compatibility: > PCL 1.0

This tutorial explains how to build the Point Cloud Library **from MacPorts and source** on Mac OS X platforms.

- `installing_homebrew`



Title: Installing on Mac OS X using Homebrew

Author: *Geoffrey Biggs*

Compatibility: > PCL 1.2

This tutorial explains how to install the Point Cloud Library on Mac OS X using Homebrew. Both direct installation and compiling PCL from source are explained.

- `using_pcl_with_eclipse`





Title: Using Eclipse as your PCL editor

Author: *Koen Buys*

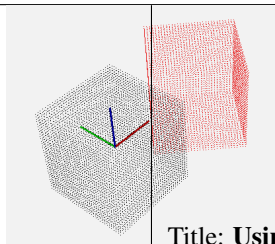
Compatibility: PCL git master

This tutorial shows you how to get your PCL as a project in Eclipse.

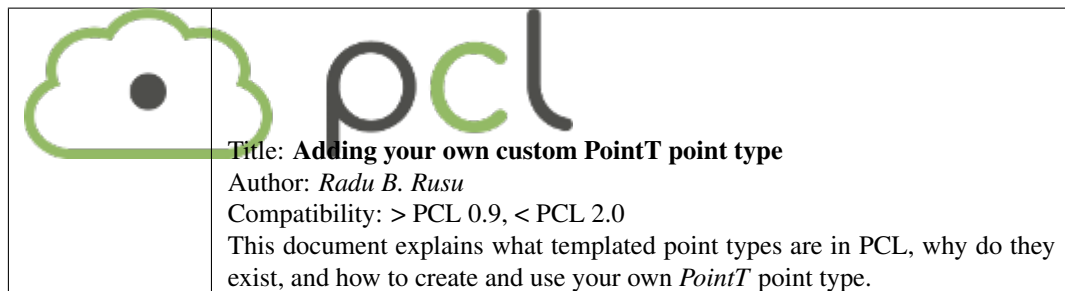
- `generate_local_doc`

	
<p>Title: Generate a local documentation for PCL Author: <i>Victor Lamoine</i> Compatibility: PCL > 1.0 This tutorial shows you how to generate and use a local documentation for PCL.</p>	

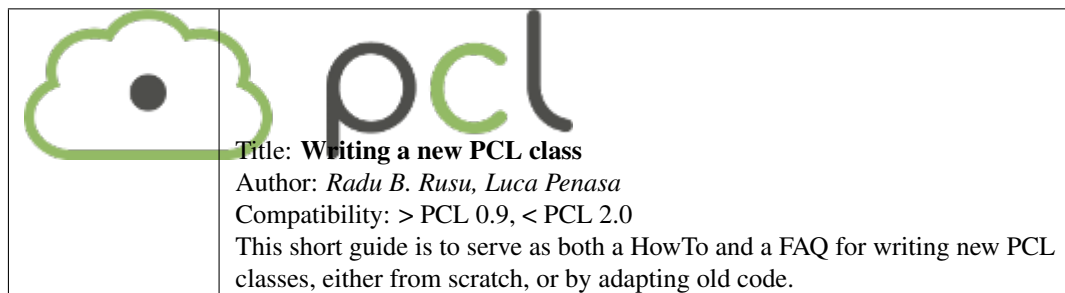
- matrix_transform

	<p>Title: Using matrixes to transform a point cloud Author: <i>Victor Lamoine</i> Compatibility: > PCL 1.5 This tutorial shows you how to transform a point cloud using a matrix.</p>
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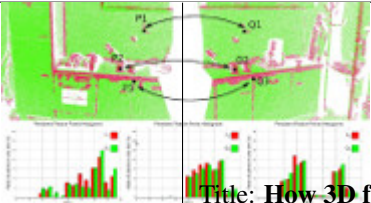
- adding_custom_ptype



- writing_new_classes

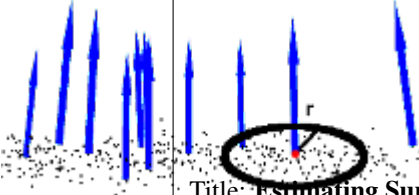


- `how_3d_features_work`



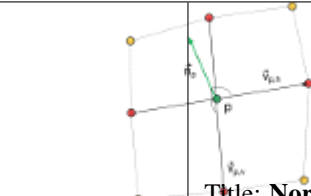
Title: How 3D features work
Author: *Radu B. Rusu*
Compatibility: > PCL 1.0
This document presents a basic introduction to the 3D feature estimation methodologies in PCL.

- `normal_estimation`



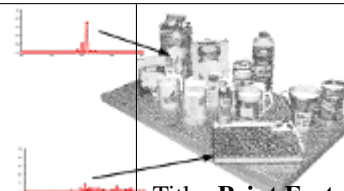
Title: Estimating Surface Normals in a PointCloud
Author: *Radu B. Rusu*
Compatibility: > PCL 1.0
This tutorial discusses the theoretical and implementation details of the surface normal estimation module in PCL.

- `normal_estimation_using_integral_images`



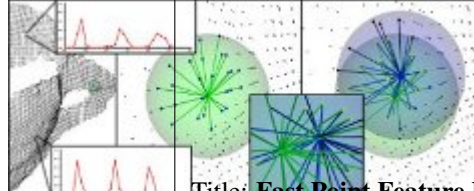
Title: Normal Estimation Using Integral Images
 Author: *Stefan Holzer*
 Compatibility: > PCL 1.0
 In this tutorial we will learn how to compute normals for an organized point cloud using integral images.

- pfh_estimation



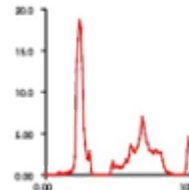
Title: Point Feature Histograms (PFH) descriptors
 Author: *Radu B. Rusu*
 Compatibility: > PCL 1.0
 This tutorial introduces a family of 3D feature descriptors called PFH (Point Feature Histograms) and discusses their implementation details from PCL's perspective.

- fpfh_estimation



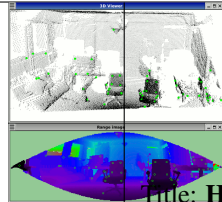
Title: Fast Point Feature Histograms (FPFH) descriptors
 Author: *Radu B. Rusu*
 Compatibility: > PCL 1.3
 This tutorial introduces the FPFH (Fast Point Feature Histograms) 3D descriptor and discusses their implementation details from PCL's perspective.

- vfh_estimation



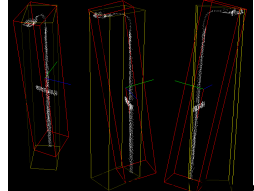
Title: Estimating VFH signatures for a set of points
 Author: *Radu B. Rusu*
 Compatibility: > PCL 0.8
 This document describes the Viewpoint Feature Histogram (VFH) descriptor, a novel representation for point clusters for the problem of Cluster (e.g., Object) Recognition and 6DOF Pose Estimation.

- narf_feature_extraction



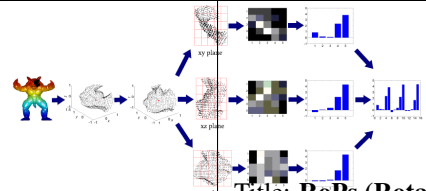
Title: How to extract NARF features from a range image
 Author: *Bastian Steder*
 Compatibility: > 1.3
 In this tutorial, we will learn how to extract NARF features from a range image.

- moment_of_inertia



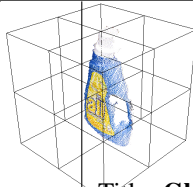
Title: Moment of inertia and eccentricity based descriptors
 Author: *Sergey Ushakov*
 Compatibility: > PCL 1.7
 In this tutorial we will learn how to compute moment of inertia and eccentricity of the cloud. In addition to this we will learn how to extract AABB and OBB.

- rops_feature



Title: RoPs (Rotational Projection Statistics) feature
 Author: *Sergey Ushakov*
 Compatibility: > PCL 1.7
 In this tutorial we will learn how to compute RoPS feature.

- gasd_estimation



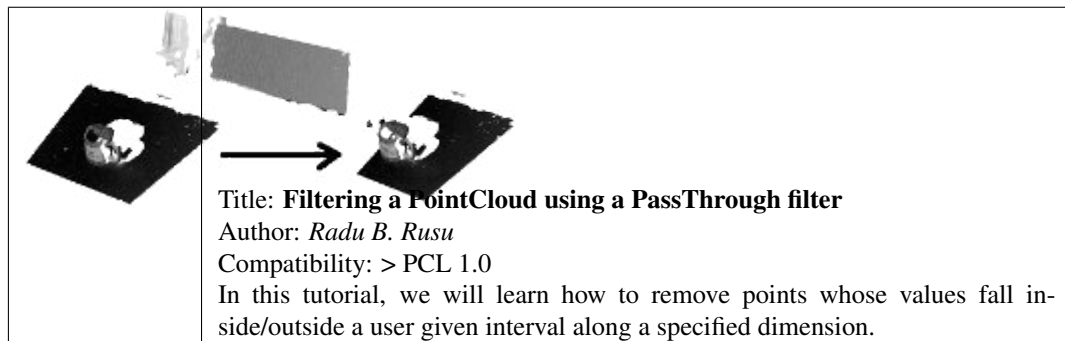
Title: **Globally Aligned Spatial Distribution (GASD) descriptors**

Author: *Joao Paulo Lima*

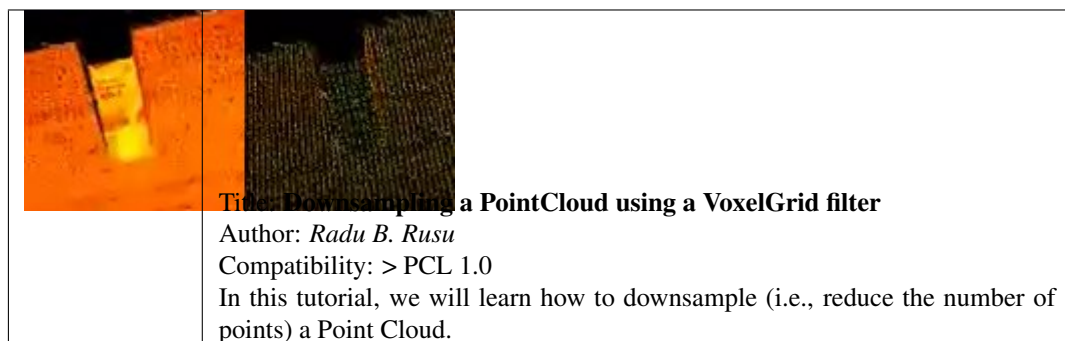
Compatibility: \geq PCL 1.9

This document describes the Globally Aligned Spatial Distribution (GASD) global descriptor to be used for efficient object recognition and pose estimation.

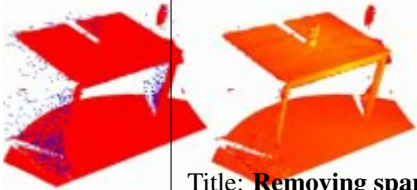
- passthrough



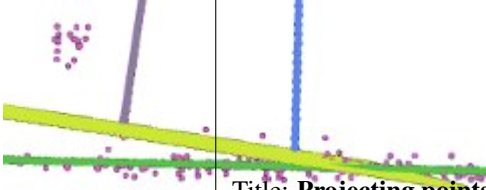
- voxelgrid




- statistical_outlier_removal

	<p>Title: Removing sparse outliers using StatisticalOutlierRemoval Author: <i>Radu B. Rusu</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to remove sparse outliers from noisy data, using StatisticalRemoval.</p>
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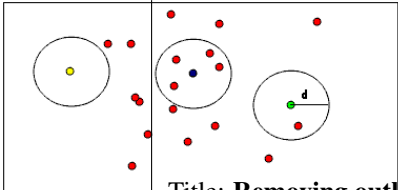
- project_inliers

	<p>Title: Projecting points using a parametric model Author: <i>Radu B. Rusu</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to project points to a parametric model (i.e., plane).</p>
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- extract_indices

	<p>Title: Extracting indices from a PointCloud Author: <i>Radu B. Rusu</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to extract a set of indices given by a segmentation algorithm.</p>
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- remove_outliers


	<p>Title: Removing outliers using a Conditional or RadiusOutlier removal Author: <i>Gabe O'Leary</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to remove outliers from noisy data, using ConditionalRemoval, RadiusOutlierRemoval.</p>
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- pcd_file_format




Title: The PCD (Point Cloud Data) file format
Author: Radu B. Rusu
Compatibility: > PCL 0.9
 This document describes the PCD file format, and the way it is used inside PCL.

- reading_pcd



Reading Point Cloud data from PCD files
Author: Radu B. Rusu
Compatibility: > PCL 1.0
 In this tutorial, we will learn how to read a Point Cloud from a PCD file.

- writing_pcd



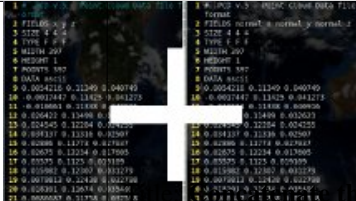
Title: Writing Point Cloud data to PCD files

Author: *Radu B. Rusu*

Compatibility: > PCL 1.0

In this tutorial, we will learn how to write a Point Cloud to a PCD file.

- concatenate_clouds




Title: Concatenating the fields or points of two Point Clouds

Author: *Gabe O'Leary / Radu B. Rusu*

Compatibility: > PCL 1.0

In this tutorial, we will learn how to concatenate both the fields and the point data of two Point Clouds. When concatenating fields, one PointClouds contains only XYZ data, and the other contains *Surface Normal* information.

- openni_grabber




Title: Grabbing Point Clouds from an OpenNI camera

Author: *Nico Blodow*

Compatibility: > PCL 1.0

In this tutorial, we will learn how to acquire point cloud data from an OpenNI camera.

- hdl_grabber




Title: Grabbing Point Clouds from a Velodyne High Definition LiDAR (HDL)

Author: *Keven Ring*


Compatibility: >= PCL 1.7

In this tutorial, we will learn how to acquire point cloud data from a Velodyne HDL.


- `dinast_grabber`

	<p>Title: Grabbing Point Clouds from Dinast Cameras Author: <i>Marco A. Gutierrez</i> Compatibility: \geq PCL 1.7 In this tutorial, we will learn how to acquire point cloud data from a Dinast camera.</p>
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- `ensenso_cameras`

	<p>Title: Grabbing point clouds from Ensenso cameras Author: <i>Victor Lamoine</i> Compatibility: \geq PCL 1.8.0 In this tutorial, we will learn how to acquire point cloud data from an IDS-Imaging Ensenso camera.</p>
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- `david_sdk`

	<p>Title: Grabbing point clouds / meshes from davidSDK scanners Author: <i>Victor Lamoine</i> Compatibility: \geq PCL 1.8.0 In this tutorial, we will learn how to acquire point cloud or mesh data from a davidSDK scanner.</p>
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- `depth_sense_grabber`



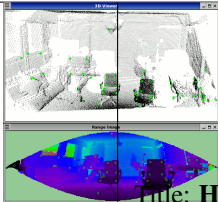
Title: Grabbing point clouds from DepthSense cameras

Author: *Sergey Alexandrov*

Compatibility: \geq PCL 1.8.0

In this tutorial we will learn how to setup and use DepthSense cameras within PCL on both Linux and Windows platforms.

- narf_keypoint_extraction



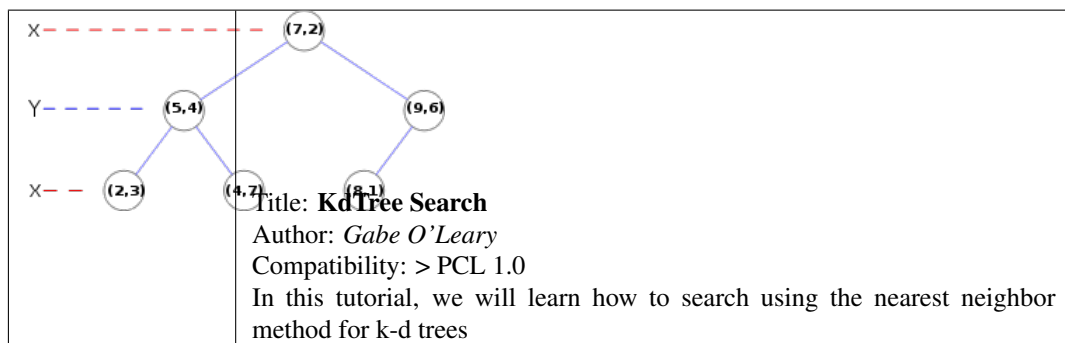
Title: How to extract NARF keypoints from a range image

Author: *Bastian Steder*


Compatibility: > 1.3

In this tutorial, we will learn how to extract NARF keypoints from a range image.

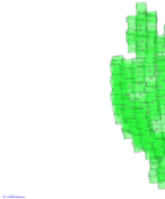
- kdtree_search



- octree_compression

	<ul style="list-style-type: none">• Title: Point cloud compression Author: <i>Julius Kammerl</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to compress a single point cloud and streams of point clouds.
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- octree_search

	<ul style="list-style-type: none">• Title: Octrees for spatial partitioning and neighbor search Author: <i>Julius Kammerl</i> Compatibility: > PCL 1.0 In this tutorial, we will learn how to use octrees for spatial partitioning and nearest neighbor search.
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- octree_change_detection



Title: Spatial change detection on unorganized point cloud data

Author: *Julius Kammerl*

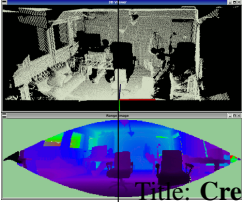
Compatibility: > PCL 1.0

In this tutorial, we will learn how to use octrees for detecting spatial changes within point clouds.

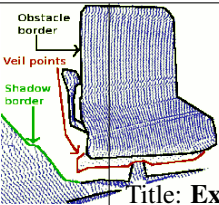
CHAPTER 9

Range Images

- range_image_creation

	<p>Title: Creating Range Images from Point Clouds Author: <i>Bastian Steder</i> Compatibility: > PCL 1.0 This tutorial demonstrates how to create a range image from a point cloud and a given sensor position.</p>
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- range_image_border_extraction

	<p>Title: Extracting borders from Range Images Author: <i>Bastian Steder</i> Compatibility: > PCL 1.3 This tutorial demonstrates how to extract borders (traversals from foreground to background) from a range image.</p>
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- `correspondence_grouping`



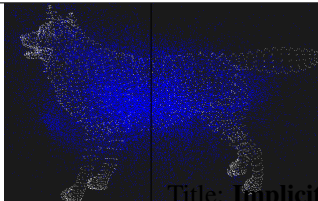
Title: The PCL Recognition API

Author: *Tommaso Cavallari, Federico Tombari*

Compatibility: > PCL 1.6

This tutorial aims at explaining how to perform 3D Object Recognition based on the `pcl_recognition` module.

- `implicit_shape_model`



Title: Implicit Shape Model

Author: *Sergey Ushakov*

Compatibility: > PCL 1.7

In this tutorial we will learn how the Implicit Shape Model algorithm works and how to use it for finding objects centers.

- `global_hypothesis_verification`



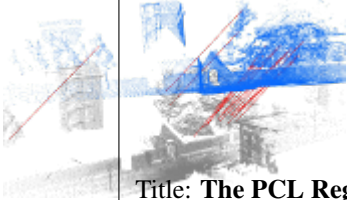
Verification for 3D Object Recognition

Author: *Daniele De Gregorio, Federico Tombari*

Compatibility: > PCL 1.7

This tutorial aims at explaining how to do 3D object recognition in clutter by verifying model hypotheses in cluttered and heavily occluded 3D scenes.

- registration_api

	<p>Title: The PCL Registration API Author: <i>Dirk Holz, Radu B. Rusu, Jochen Sprickerhof</i> Compatibility: > PCL 1.5 In this document, we describe the point cloud registration API and its modules: the estimation and rejection of point correspondences, and the estimation of rigid transformations.</p>
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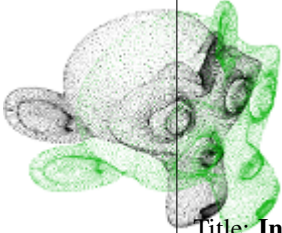
- iterative_closest_point

	<p>Title: How to use iterative closest point algorithm Author: <i>Gabe O'Leary</i> Compatibility: > PCL 1.0 This tutorial gives an example of how to use the iterative closest point algorithm to see if one PointCloud is just a rigid transformation of another PointCloud.</p>
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- pairwise_incremental_registration

	<p>Title: How to incrementally register pairs of clouds Author: <i>Raphael Favier</i> Compatibility: > PCL 1.4 This document demonstrates using the Iterative Closest Point algorithm in order to incrementally register a series of point clouds two by two.</p>
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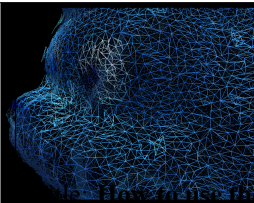
- `interactive_icp`

	<p>Title: Interactive ICP Author: <i>Victor Lamoine</i> Compatibility: > PCL 1.5 This tutorial will teach you how to build an interactive ICP program</p>
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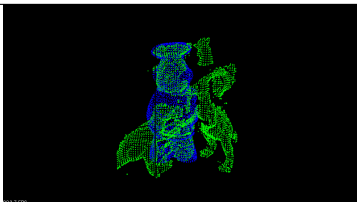
- `normal_distributions_transform`

	<p>Title: How to use the Normal Distributions Transform algorithm Author: <i>Brian Okorn</i> Compatibility: > PCL 1.6 This document demonstrates using the Normal Distributions Transform algorithm to register two large point clouds.</p>
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- `in_hand_scanner`

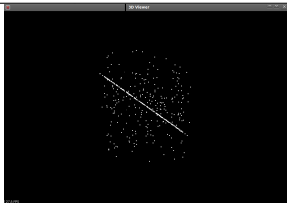
		<p>Title: Using the In-hand scanner for small objects Author: <i>Martin Saelzle</i> Compatibility: >= PCL 1.7 This document shows how to use the In-hand scanner applications to obtain colored models of small objects with RGB-D cameras.</p>
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- `alignment_prerejective`

	<p>Title: Alignment prerejective registration of rigid objects Author: <i>Anders Glent Buch</i> Compatibility: >= PCL 1.7 In this tutorial, we show how to find the alignment pose of a rigid object in a scene with clutter and occlusions.</p>
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Sample Consensus

- `random_sample_consensus`



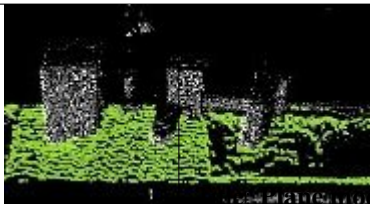
use Random Sample Consensus model

Author: *Gabe O'Leary*

Compatibility: > PCL 1.0

In this tutorial we learn how to use a `RandomSampleConsensus` with a plane model to obtain the cloud fitting to this model.

- planar_segmentation



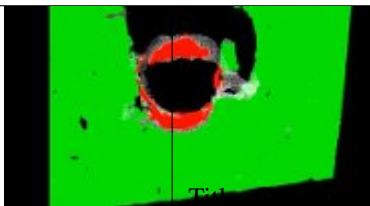
planar segmentation

Author: *Radu B. Rusu*

Compatibility: > PCL 1.3

In this tutorial, we will learn how to segment arbitrary plane models from a given point cloud dataset.

- cylinder_segmentation



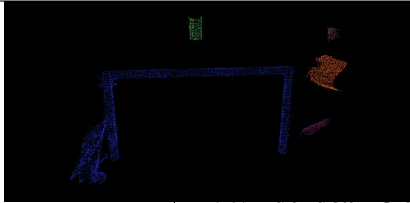
cylinder segmentation

Author: *Radu B. Rusu*

Compatibility: > PCL 1.3

In this tutorial, we will learn how to segment arbitrary cylindrical models from a given point cloud dataset.

- cluster_extraction



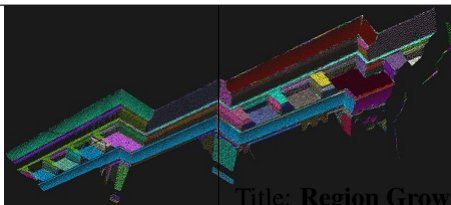
Cluster Extraction

Author: *Serkan Tuerker*

Compatibility: > PCL 1.3

In this tutorial we will learn how to extract Euclidean clusters with the `pcl::EuclideanClusterExtraction` class.

- `region_growing_segmentation`



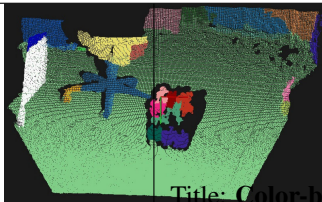
Title: Region Growing Segmentation

Author: *Sergey Ushakov*

Compatibility: \geq PCL 1.7

In this tutorial we will learn how to use region growing segmentation algorithm.

- `region_growing_rgb_segmentation`



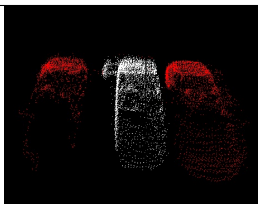
Title: Color-based Region Growing Segmentation

Author: *Sergey Ushakov*

Compatibility: \geq PCL 1.7

In this tutorial we will learn how to use color-based region growing segmentation algorithm.

- `min_cut_segmentation`



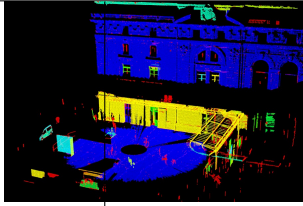
Min-Cut Based Segmentation

Author: *Sergey Ushakov*

Compatibility: \geq PCL 1.7

In this tutorial we will learn how to use min-cut based segmentation algorithm.

- conditional_euclidean_clustering



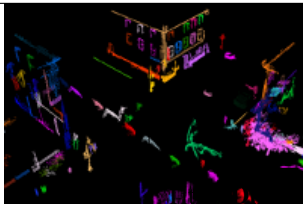
Conditional Euclidean Clustering

Author: *Frits Florentinus*

Compatibility: \geq PCL 1.7

This tutorial describes how to use the Conditional Euclidean Clustering class in PCL: A segmentation algorithm that clusters points based on Euclidean distance and a user-customizable condition that needs to hold.

- don_segmentation



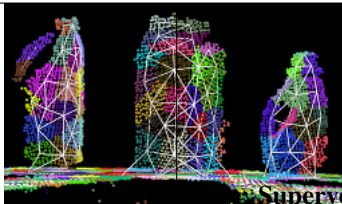
Difference of Normals Based Segmentation

Author: *Yani Ioannou*

Compatibility: \geq PCL 1.7

In this tutorial we will learn how to use the difference of normals feature for segmentation.

- supervoxel_clustering



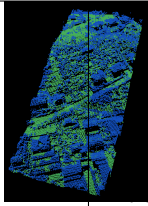
Supervoxel Clustering

Author: *Jeremie Papon*

Compatibility: \geq PCL 1.8

In this tutorial, we show to break a pointcloud into the mid-level supervoxel representation.

- progressive_morphological_filtering



Title: Progressive Morphological Filtering

Author: *Brad Chambers*

Compatibility: \geq PCL 1.8

In this tutorial, we show how to segment a point cloud into ground and non-ground returns.

- `model_outlier_removal`



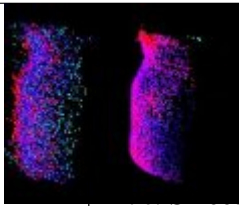
Title: Model outlier removal

Author: *Timo Häckel*

Compatibility: \geq PCL 1.7.2

This tutorial describes how to extract points from a point cloud using SAC models

- moving_least_squares



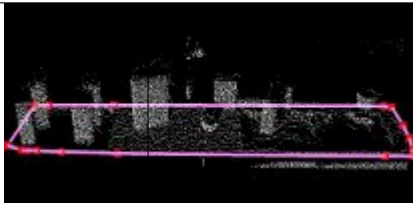
Smoothing and normal estimation based on polynomial reconstruction

Author: *Zoltan-Csaba Marton, Alexandru E. Ichim*

Compatibility: > PCL 1.6

In this tutorial, we will learn how to construct and run a Moving Least Squares (MLS) algorithm to obtain smoothed XYZ coordinates and normals.

- hull_2d




Concave or convex hull polygon for a plane model

Author: *Gabe O'Leary, Radu B. Rusu*

Compatibility: > PCL 1.0

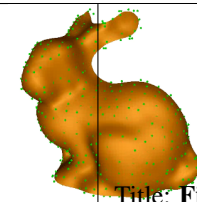
In this tutorial we will learn how to calculate a simple 2D concave or convex hull polygon for a set of points supported by a plane.

- greedy_triangulation



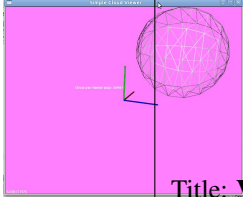
Title: Fast triangulation of unordered point clouds
Author: *Zoltan-Csaba Marton*
Compatibility: > PCL 1.0
In this tutorial we will learn how to run a greedy triangulation algorithm on a Point-Cloud with normals to obtain a triangle mesh based on projections of the local neighborhood.

- bspline_fitting



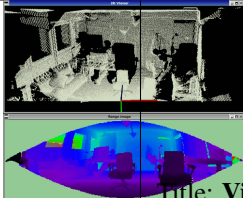
Title: Fitting trimmed B-splines to unordered point clouds
Author: *Thomas Mörwald*
Compatibility: > PCL 1.7
In this tutorial we will learn how to reconstruct a smooth surface from an unordered point-cloud by fitting trimmed B-splines.

- cloud_viewer



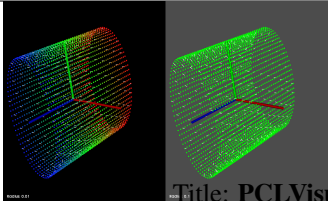
Title: Visualizing Point Clouds
Author: *Ethan Rublee*
Compatibility: > PCL 1.0
This tutorial demonstrates how to use the pcl visualization tools.

- range_image_visualization

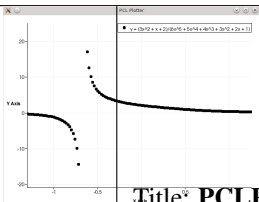


Title: Visualizing Range Images
Author: *Bastian Steder*
Compatibility: > PCL 1.3
This tutorial demonstrates how to use the pcl visualization tools for range images.

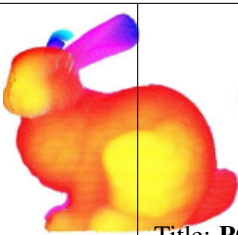
- pcl_visualizer

	<p>Title: PCLVisualizer Author: <i>Geoffrey Biggs</i> Compatibility: > PCL 1.3 This tutorial demonstrates how to use the PCLVisualizer class for powerful visualisation of point clouds and related data.</p>
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- pcl_plotter

	<p>Title: PCLPlotter Author: <i>Kripasindhu Sarkar</i> Compatibility: > PCL 1.7 This tutorial demonstrates how to use the PCLPlotter class for powerful visualisation of plots, charts and histograms of raw data and explicit functions.</p>
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- visualization

	<p>Title: PCL Visualization overview Author: <i>Radu B. Rusu</i> Compatibility: >= PCL 1.0 This tutorial will give an overview on the usage of the PCL visualization tools.</p>
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- qt_visualizer



Title: **Create a PCL visualizer in Qt with cmake**

Author: *Victor Lamoine*

Compatibility: > PCL 1.5

This tutorial shows you how to create a PCL visualizer within a Qt application.

- qt_colorize_cloud



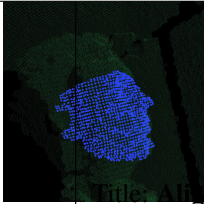
Title: **Create a PCL visualizer in Qt to colorize clouds**

Author: *Victor Lamoine*

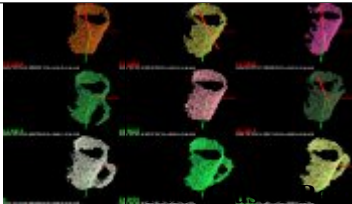
Compatibility: > PCL 1.5

This tutorial shows you how to color point clouds within a Qt application.

- `template_alignment`

	<p>Title: Aligning object templates to a point cloud</p> <p>Author: <i>Michael Dixon</i></p> <p>Compatibility: > PCL 1.3</p> <p>This tutorial gives an example of how some of the tools covered in the previous tutorials can be combined to solve a higher level problem — aligning a previously captured model of an object to some newly captured data.</p>
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- `vfh_recognition`

	<p>Recognition and 6DOF Pose Estimation using VFH descriptors</p> <p>Author: <i>Radu B. Rusu</i></p> <p>Compatibility: > PCL 0.8</p> <p>In this tutorial we show how the Viewpoint Feature Histogram (VFH) descriptor can be used to recognize similar clusters in terms of their geometry.</p>
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- `mobile_streaming`



Title: Point Cloud Streaming to Mobile Devices with Real-time Visualization

Author: *Pat Marion*

Compatibility: > PCL 1.3

This tutorial describes how to send point cloud data over the network from a desktop server to a client running on a mobile device.

- `ground_based_rgbd_people_detection`




Title: Detecting people on a ground plane with RGB-D data

Author: *Matteo Munaro*

Compatibility: \geq PCL 1.7

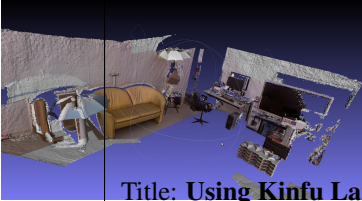
This tutorial presents a method for detecting people on a ground plane with RGB-D data.

- `gpu_install`




Title: GPU Installation
Author: *Koen Buys*
Compatibility: PCL git master
This tutorial explains how to configure PCL to use with a Nvidia GPU

- `using_kinfu_large_scale`



Title: Using KinFu Large Scale to generate a textured mesh
Author: *Francisco Heredia and Raphael Favier*
Compatibility: PCL git master
This tutorial demonstrates how to use KinFu Large Scale to produce a mesh from a room, and apply texture information in post-processing for a more appealing visual result.

- `gpu_people`

	<p>Title: People Detection Author: <i>Koen Buys</i> Compatibility: PCL git master This tutorial presents a method for people and pose detection.</p>
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