CS 378: Autonomous Intelligent Robotics

Instructor: Jivko Sinapov

http://www.cs.utexas.edu/~jsinapov/teaching/cs378/
Introduction to Point Cloud Library (PCL)
Announcements

Homework 6 is out, due 4/5
Announcements

Homework 6 is out, due 4/5
Final Project Timeline

• Project Proposal due: Mar. 29th Apr. 1st

• Project Presentations / Demos: Last Week of Class (May 3rd and 5th)

• Final Report due: May 11th
Project Proposal

• Format: PDF, single spaced

• Submit on Canvas

• Also, post PDF on Discussion Forum, state the project name and team members
Installing our code base

• Github page:
  – https://github.com/utexas-bwi/bwi
Introduction to Point Cloud Library (PCL)
Main References


• “Tutorial: Point Cloud Library – USC Robotics Research Lab”
Why PCL?
The Impact of OpenCV
Traditional 3D sensors
Latest Technology
3D is now cheap!
What is PCL?

• Open Source C++ Library:
  • http://pointclouds.org/

• Cross-platform*
  • (Ubuntu 12.04+, Windows 7+, Mac)

• Strives to be the equivalent of OpenCV for 3D
Who is developing it?
Who is paying for it?
What is a PCL point cloud?

# .PCD v0.7 - Point Cloud Data file format
VERSION 0.7
FIELDS x y z
SIZE 4 4 4
TYPE F F F
COUNT 1 1 1
WIDTH 2500
HEIGHT 1
VIEWPOINT 0 0 1 0 0 0
POINTS 2500
DATA ascii
-0.0017353802 0.063134596 -0.047117598
-0.00391143 0.064091198 -0.047013
0.00073380599 0.064106099 -0.047437999
0.0021609101 0.063522704 -0.047437999
0.0072039799 0.063331202 -0.0471754
-0.0013178901 0.065206803 -0.0471658
0.00238145 0.0648202 -0.047421999
0.00742169 0.064781599 -0.0471754
-0.00240529 0.065845296 -0.046584301
0.0021517898 0.0657662 -0.047015704
Types of Point Clouds

- XYZ:
Types of Point Clouds

• **XYZRGB:**
Types of Point Clouds

- XYZ+Normals:
PCL Breakdown
PCL Breakdown

Diagram showing the breakdown of PCL with various modules such as visualization, registration, keypoints, features, surface, tracking, common, kdtree, sample_consensus, segmentation, filters, octree, io, search, and various others.
Getting a Point Cloud from an OpenNI Sensor

- Code sample and Demo
PCL Breakdown
Downsampling a Point Cloud
Change Detection using Octree
Octrees

An octree is a tree data structure in which each internal node has exactly eight children. Octrees are most often used to partition a three-dimensional space by recursively subdividing it into eight octants. Octrees are the three-dimensional analog of quadtrees.
Octrees

Application: change detection
Segmentation
Example:
finding the floor and the table
Robots and Tables
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D
An Example in 2D

...and so on until line stops changing
Random sample consensus (RANSAC) is an iterative method to estimate parameters of a mathematical model from a set of observed data which contains outliers. “ - Wikipedia
RANSAC
RANSAC

[http://www.visual-experiments.com/blog/wp-content/uploads/2012/04/ransac_line_fitting1.gif]
Finding a plane using RANSAC
Cylinder Detection with RANSAC

https://www.youtube.com/watch?v=tasdvsnGCH0
Cluster Extraction
Cluster Extraction

Cluster 1

Cluster 2
Cluster Extraction in PCL

• Code example
Further Applications

• Obstacle Detection:
  – https://www.youtube.com/watch?v=jHKzBMKk4hY

• Tracking 3D objects:
  – https://www.youtube.com/watch?v=NzRME9ZEOnY
Resources

• Main website: https://ointclouds.org
• Tutorials: http://pointclouds.org/documentation/tutorials/
• API: http://docs.pointclouds.org/1.7.2/
• Blog: http://pointclouds.org/blog/
THE END