

# **3D Perception with ROS and PCL**

Dipl.-Ing. Georg Arbeiter

---

# 3D Perception with ROS and PCL

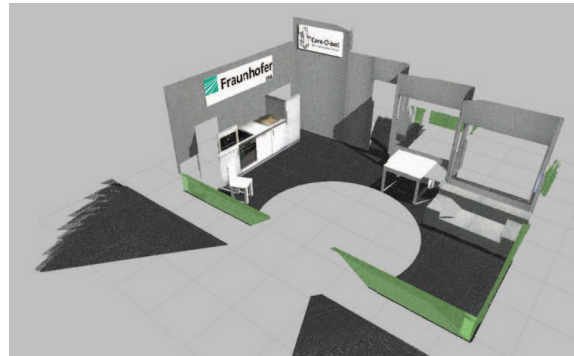
Dipl.-Ing. Georg Arbeiter

Technology Seminar – ROS in Industrial Applications

---

ROS.org

pcl



© Fraunhofer

 Fraunhofer

---

## 3D Perception with ROS and PCL

### Goals

- Introduction to 3D perception
  - Processing chain
  - Typical task
- Learn about Point Cloud Library (PCL)
  - Capabilities
  - Modules
- Learn how to use ROS for 3D perception
  - Use PCL algorithms in ROS nodes
  - Configure parameters
  - Visualize results in RVIZ
- Accomplish the task to detect an obstacle on the ground

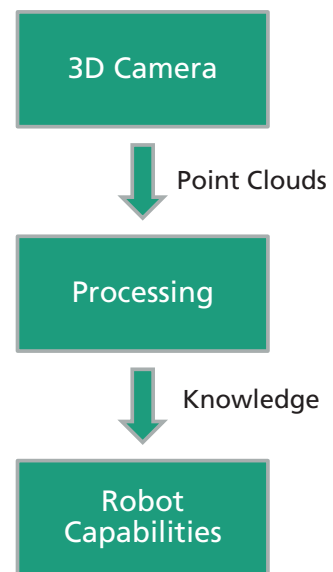
© Fraunhofer

 Fraunhofer

# Introduction to 3D Perception

## Processing Chain

- 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



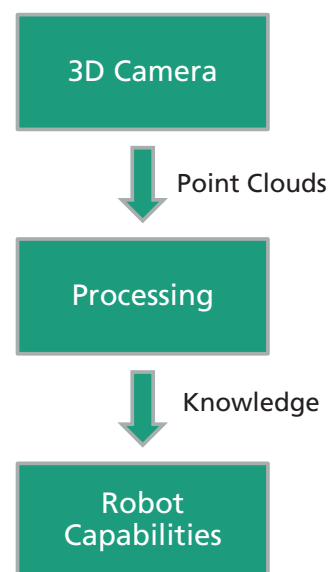
© Fraunhofer

 Fraunhofer

# Introduction to 3D Perception

## Processing Chain

- Knowledge is used for
  - Navigation and Manipulation
    - Collision-free movements
    - Recognition of objects
  - Visualization
    - Feedback to human operator
  - Planning and Reasoning
    - Recognition of objects
    - Relationship between objects



© Fraunhofer

 Fraunhofer

# Introduction to 3D Perception

## Task: Identify obstacles on the ground

- A 3D camera is mounted on a robot or AGV
- For collision-avoidance, an obstacle on the ground should be detected
- Detection should be done using ROS and PCL

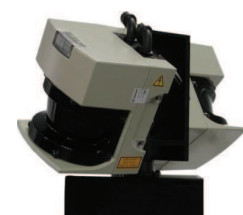
### ■ Work flow



## 3D Cameras



- RGBD cameras, TOF cameras, stereo vision, 3D laser scanner
- Produce (colored) point cloud data
- 2.5D data (view point)
- Huge data volume
  - Over 300,000 points per cloud
  - 30 Hz frame rate
- Driver for Asus Xtion camera is in the package `openni_launch`

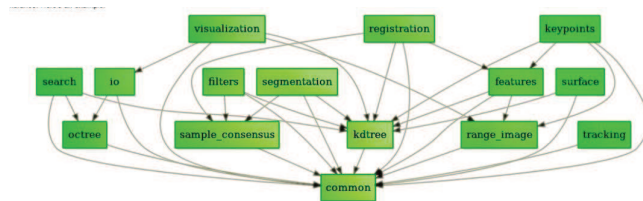


# Point Cloud Library (PCL)

## Introduction



- Large scale, open project for 2D/3D image and point cloud processing
- Contains numerous state of the art algorithms
  - Filters
  - Feature estimation
  - Registration
  - Segmentation
  - Surface reconstruction
- Released in BSD license
- Huge developer community
- ROS package: pcl



© Fraunhofer



# Point Cloud Library (PCL)

## Modules



- Base
  - Point cloud definition
  - Point types
- Filters
  - Geometric Filters (Passthrough, Crop Box)
  - Downsampling (Voxel Grid)
  - Noise Filters (Statistical Outlier Removal, Median, Shadow Points)



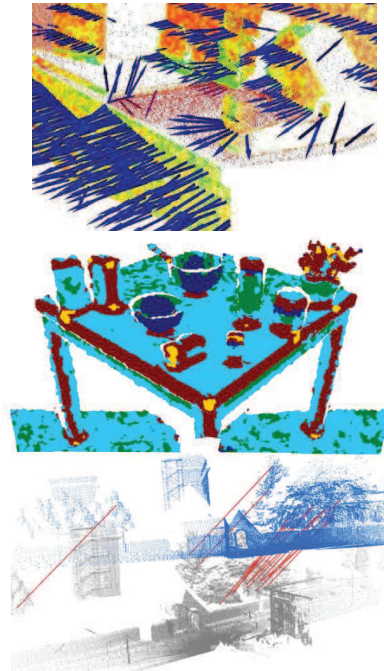
© Fraunhofer



# Point Cloud Library (PCL) Modules



- Features
  - Normals
  - Point descriptors (PC, RSD, FPFH)
  - Global features (VFH)
- Registration
  - Aligning point clouds
  - Generic framework
  - ICP, GICP, NDT
  - Support for features



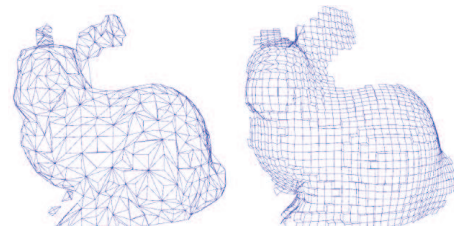
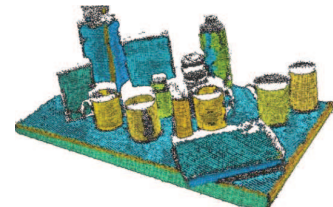
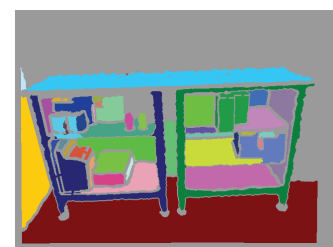
© Fraunhofer



# Point Cloud Library (PCL) Modules



- Segmentation
  - Region Growing: grow regions with similar properties (e.g. normals, colors)
  - RANSAC: fit parametric models (e.g. planes, cylinders)
- Surface reconstruction
  - Meshing: organized mesh, ear clipping
  - Hulls: concave or convex, 2D or 3D



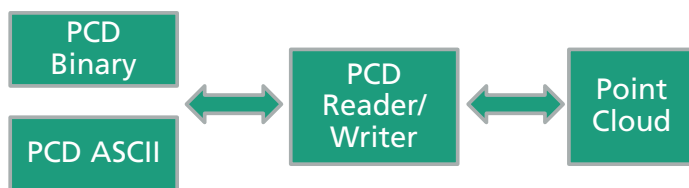
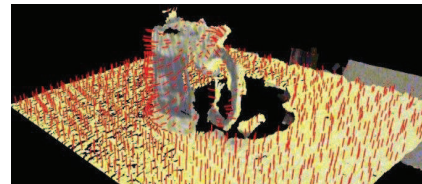
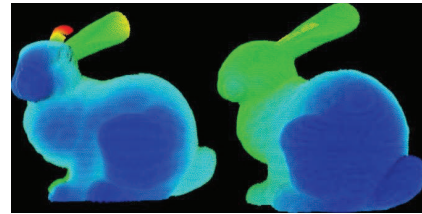
© Fraunhofer



# Point Cloud Library (PCL) Modules



- Visualization
  - PCD Viewer
  - API
  
- I/O
  - Point clouds as PCD
  - Meshes (PLY, VTK)



© Fraunhofer



# Visualization in RVIZ



- Point clouds

The screenshot shows the RVIZ interface with a point cloud of a workshop scene. A 'Color Transform' box is overlaid on the point cloud, and an inset shows the resulting color-mapped point cloud. A 'Topic' box points to the 'PointCloud2' topic in the 'Displays' panel.

© Fraunhofer

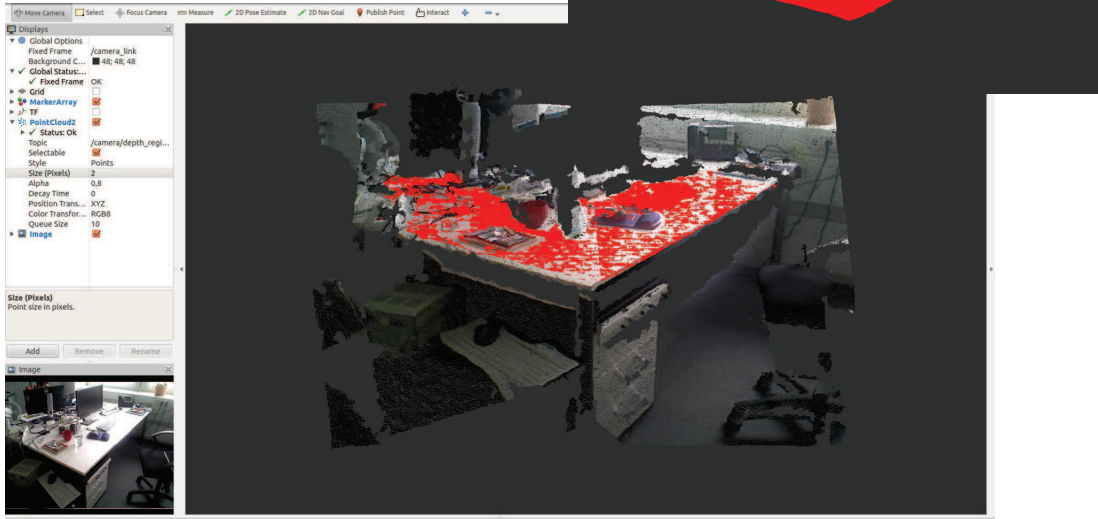




# Visualization in RVIZ



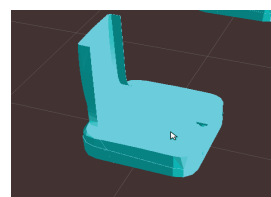
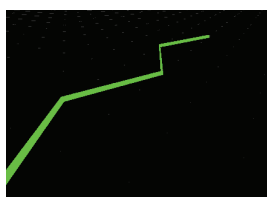
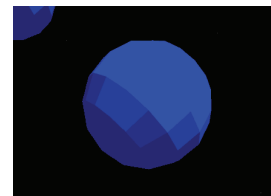
## ■ Marker



# Visualization in RVIZ



- ROS package: visualization\_msgs
- Marker Types

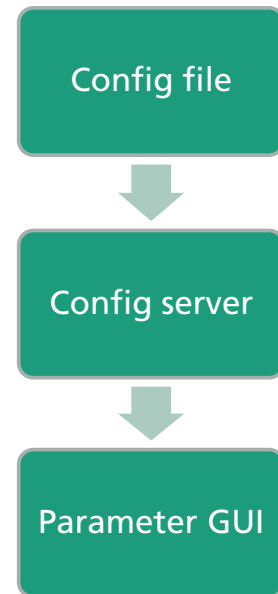




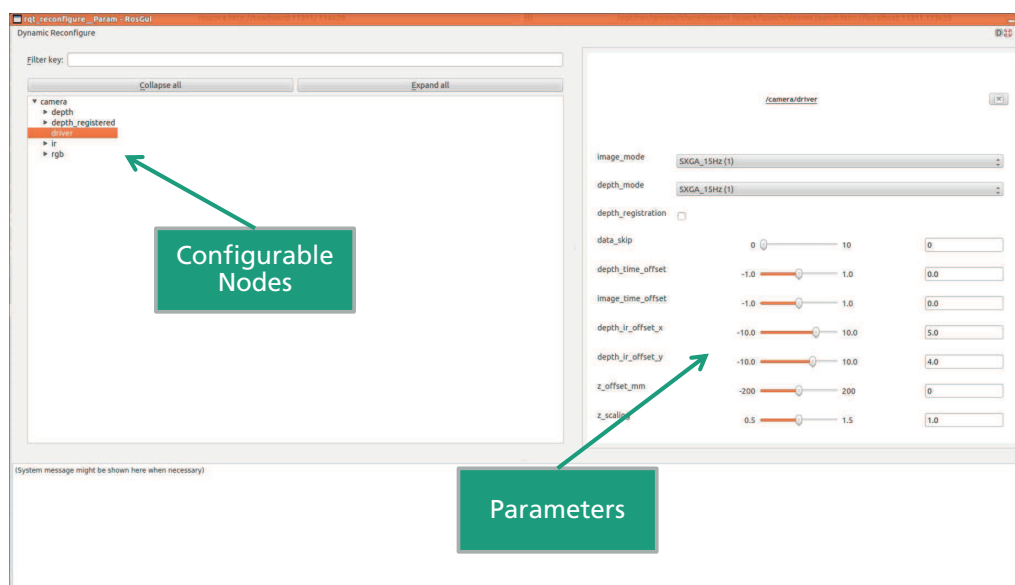
# Dynamic Reconfigure



- Change parameters of nodes dynamically
- Easy setup in config file
- GUI to check and alter parameters
- Can be combined with parameters in launch file
- Implemented using a config server in the node
- ROS package: rqt\_reconfigure

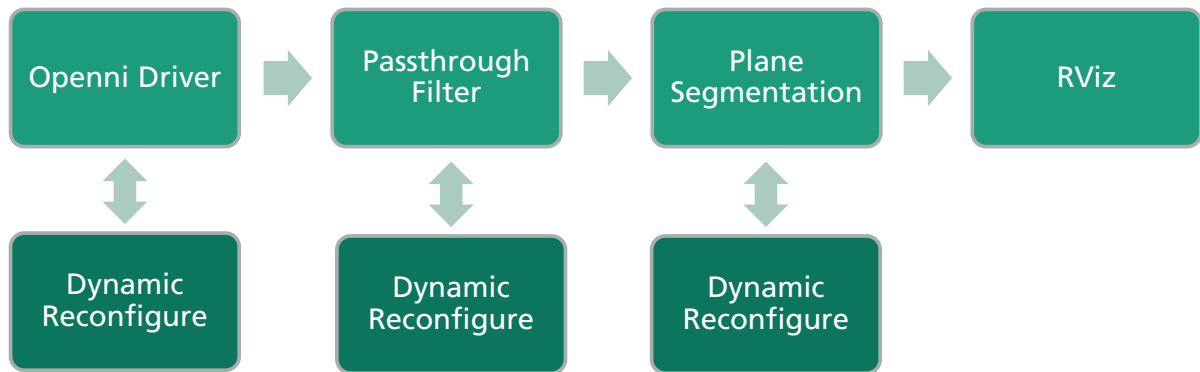


# Dynamic Reconfigure



# Processing Chain for Perception Task

- ROS nodes used for processing



© Fraunhofer



## 3D Perception with ROS and PCL Your perception expert



Dipl. -Ing. Georg Arbeiter

E-Mail: [georg.arbeiter@ipa.fraunhofer.de](mailto:georg.arbeiter@ipa.fraunhofer.de)

Phone: +49 711 970-1299

© Fraunhofer





**Stuttgarter  
Produktionsakademie**

# ROS IN DER INDUSTRIELLEN ANWENDUNG

Seminar **SPA 054**  
6. März 2014  
Stuttgart