3D Perception with ROS and PCL

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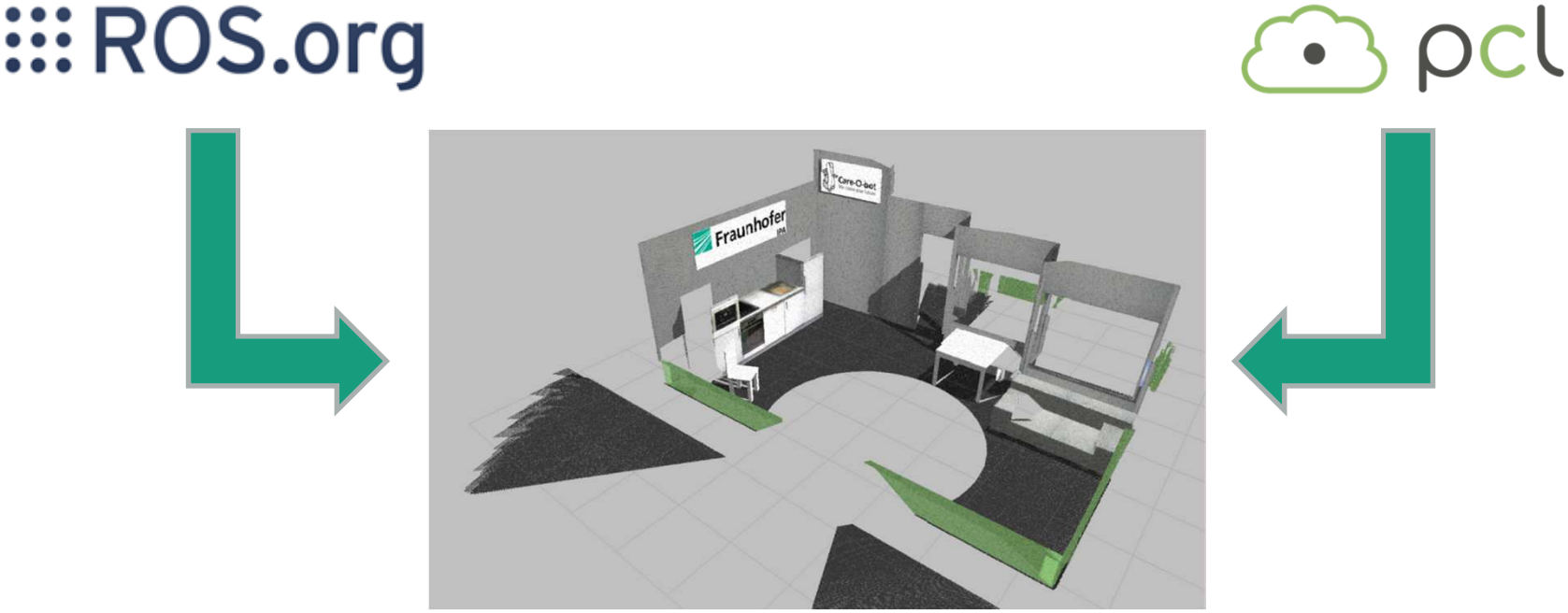
Technology Seminar – ROS in Industrial Applications

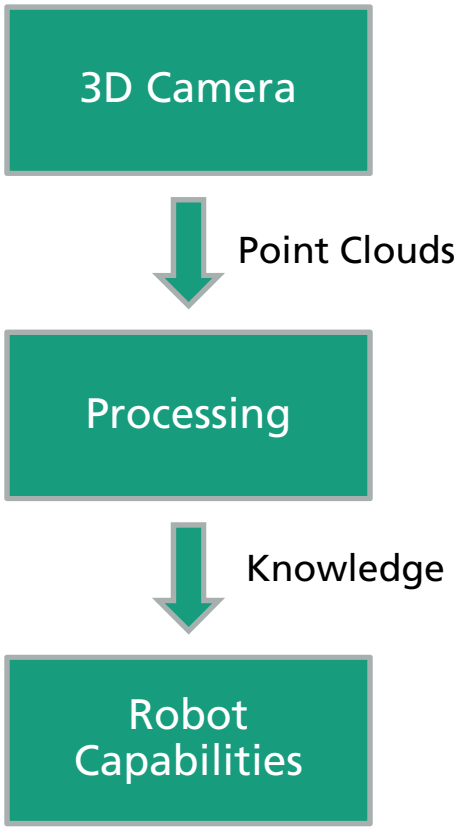


3D Perception with ROS and PCL
Goals

- 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

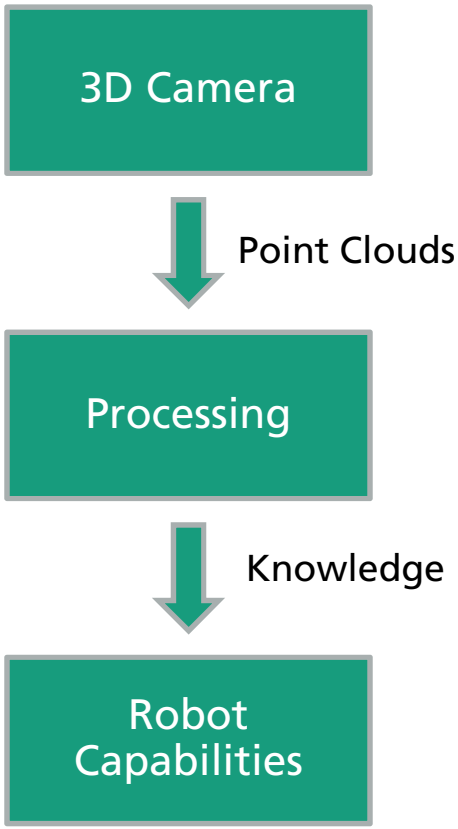
Introduction to 3D Perception
Processing Chain

- 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



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



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

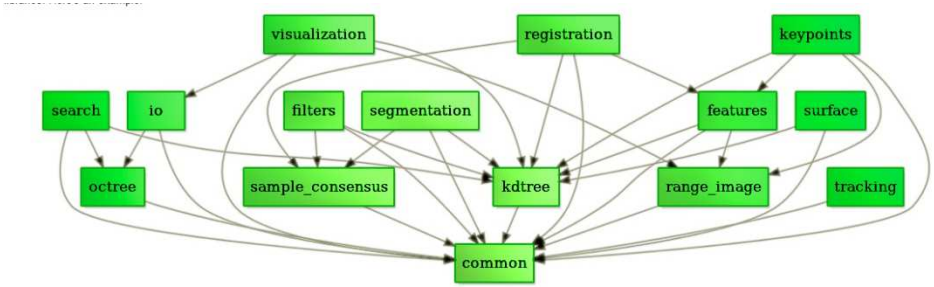
- Work flow

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



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)

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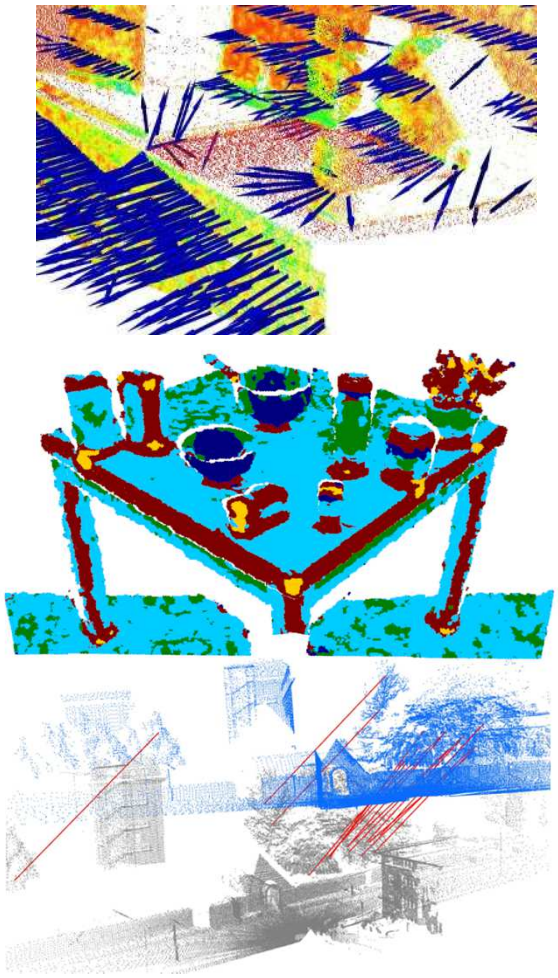
Point Cloud Library (PCL)
Modules

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



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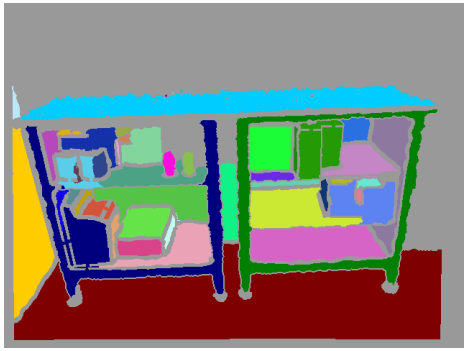
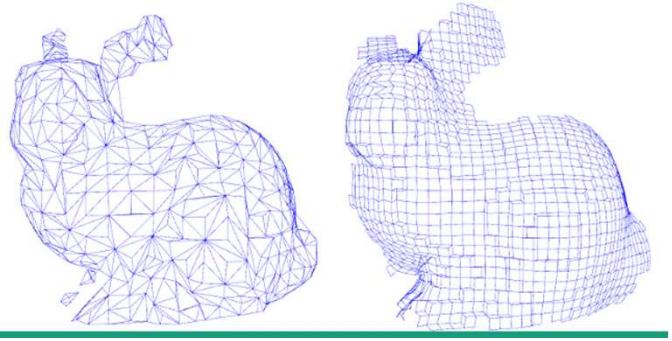
Point Cloud Library (PCL)
Modules

- 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



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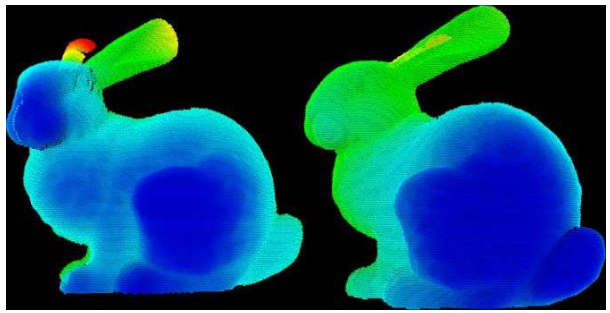
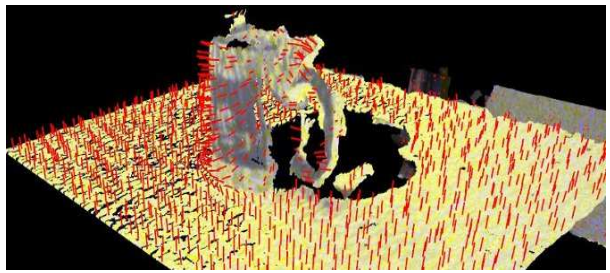
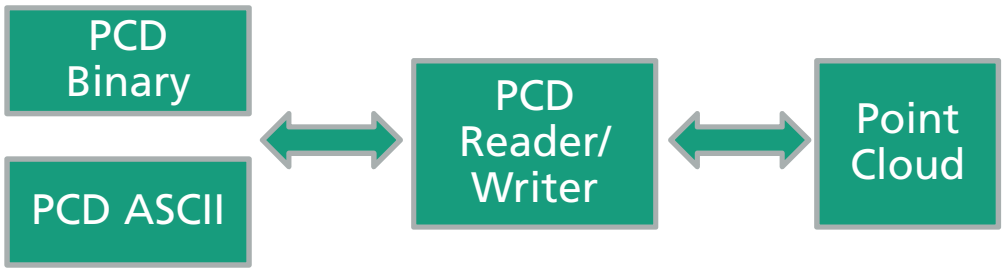
Point Cloud Library (PCL)
Modules

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







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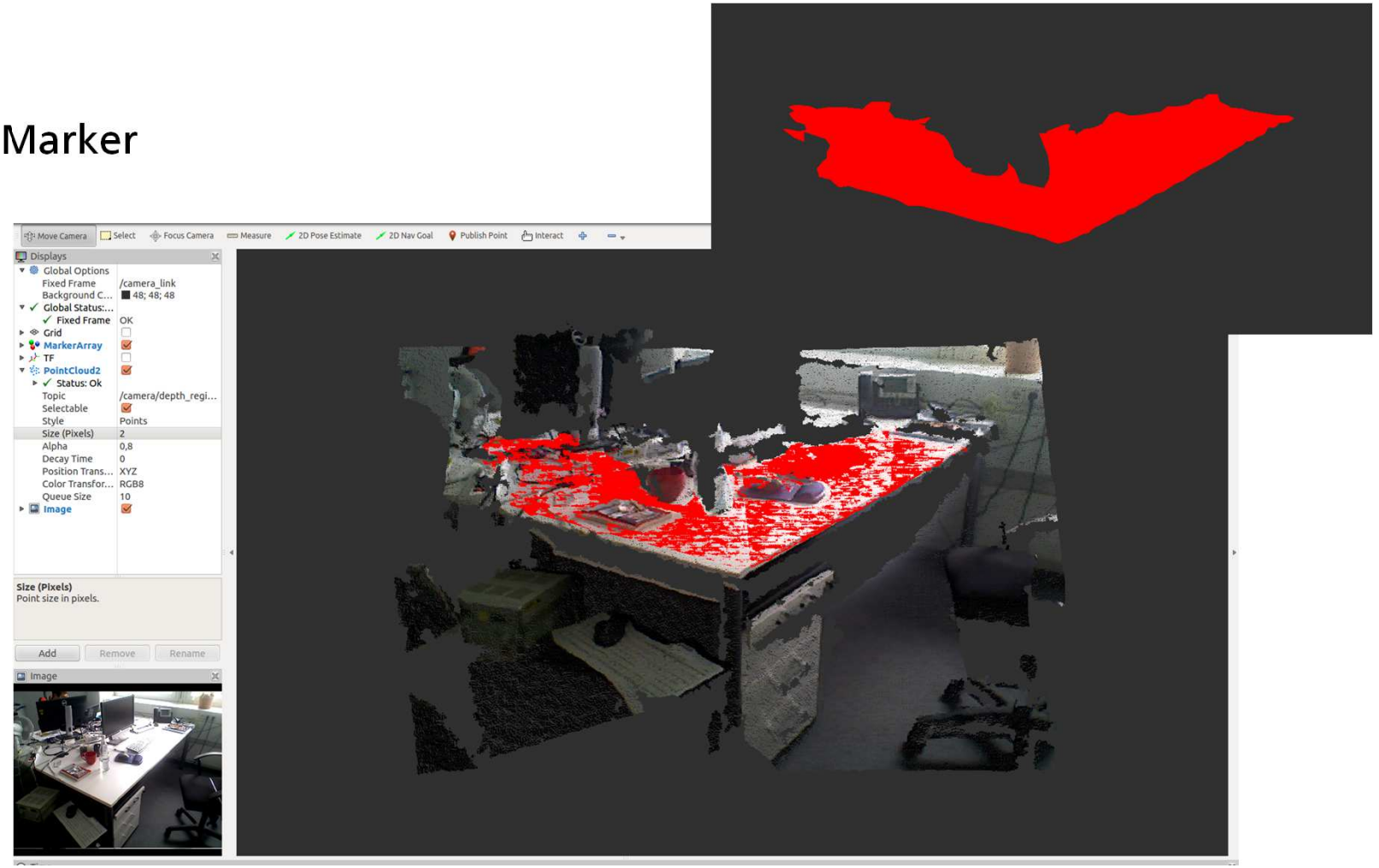
Visualization in RVIZ

- Point clouds

Visualization in RVIZ

- Marker



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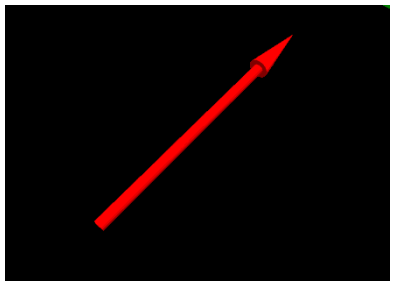
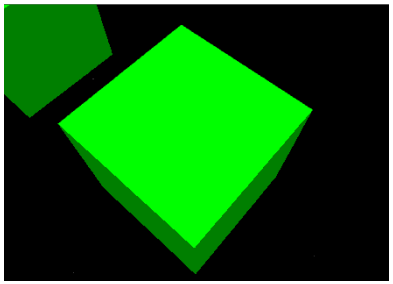
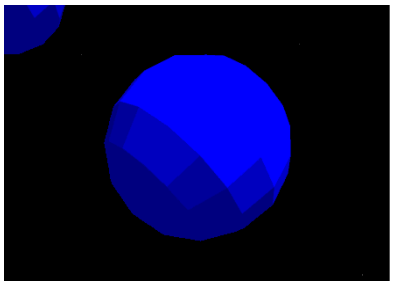
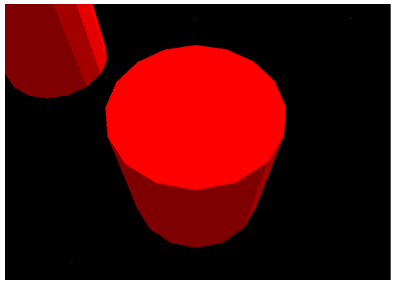
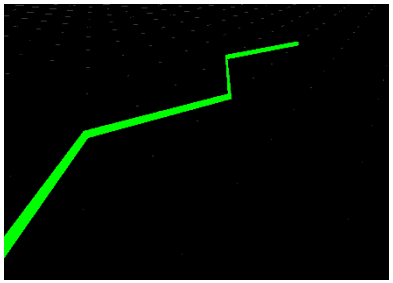
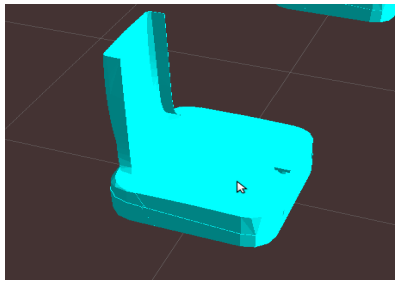
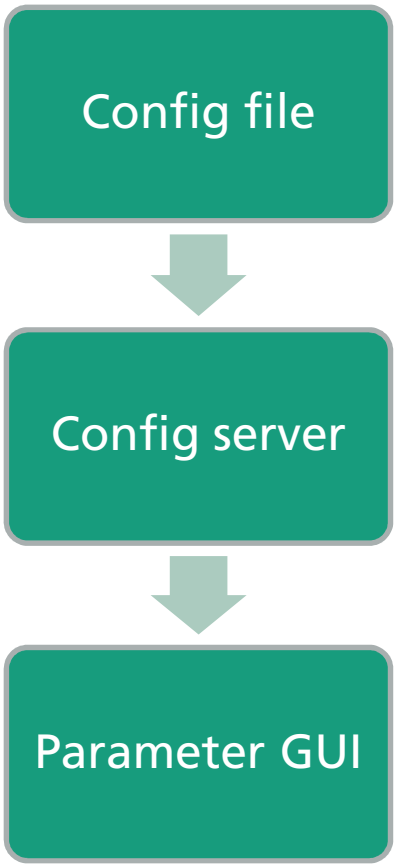
Visualization in RVIZ

- ROS package: visualization_msgs
- Marker Types

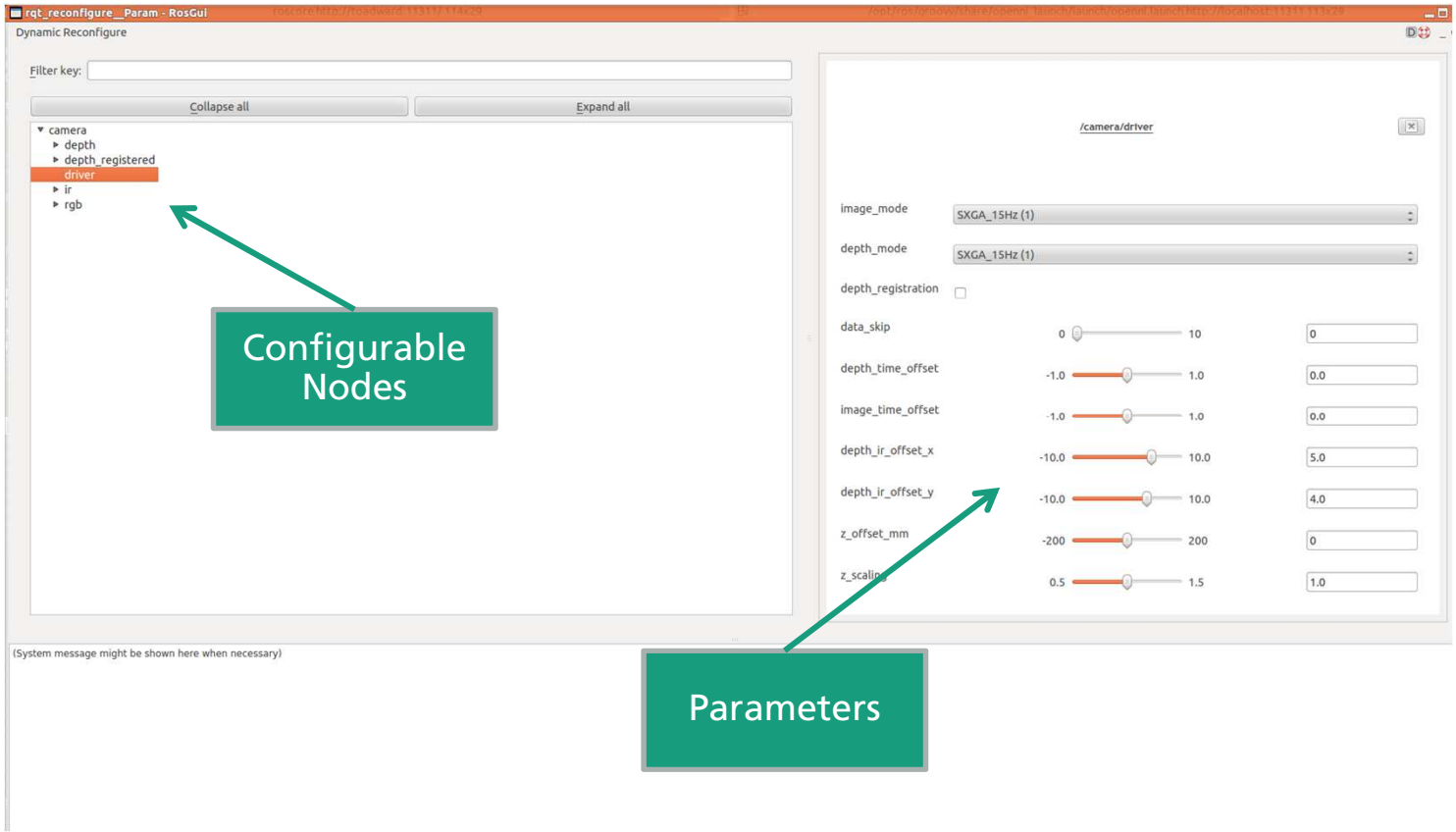
Dynamic Reconfigure

- 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

Start camera driver → Start processing chain → Visualize Results → Configure Parameters



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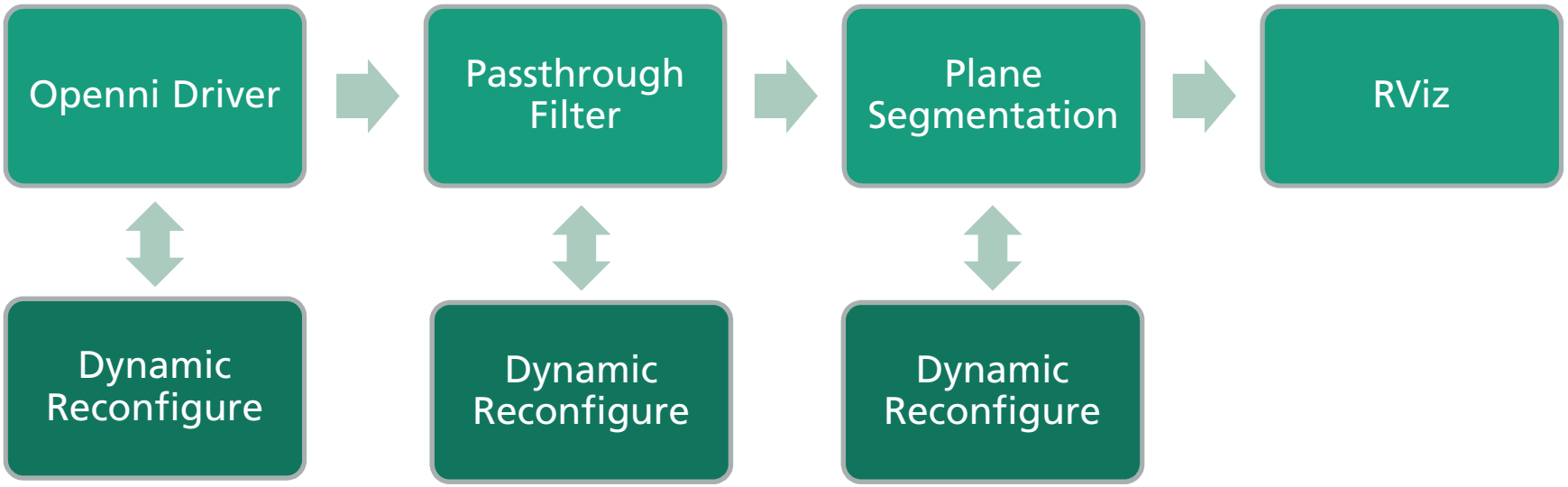
Processing Chain for Perception Task

- ROS nodes used for processing



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Your perception expert

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