Modeling the World Around Us
An Efficient 3D Representation for Personal Robotics

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Personal Robotics

- Robots operate in environment “as is”
  - Lots of clutter
  - Changing environment
  - Three-dimensional obstacles
  - Three-dimensional navigation (arms etc.)
Challenges for Mapping

- **Large-scale 3D maps** of static environments
- **Collision map** of working space
  - Real-time updates
  - Clear outdated information
  - Sensor fusion (several sensors)
- **Semantic mapping**
  - Mapping beyond obstacles / freespace
  - Make use of **semantic classes** (i.e., walls, floor, objects)
Large-scale 3D maps of static environments

Freiburg campus
:: octomap

- Probabilistic 3d mapping framework
- Based on octrees
- Optimized for memory efficiency
- Open source, BSD licensed
0.5 Willow Garage Building
:: mapping3d

- 3D mapping system for the PR2
- Offline open-loop 3D SLAM
- ICP-based registration (PCL)

- Laser scans acquired in stop-and-go fashion, see :: mapping_tools
Collision maps for mobile manipulation
:: octomap2

- Optimized for online operation
- Optional per-voxel timestamps
- Supports hierarchical mapping

→ Online 5D mapping

- Tighter ROS integration (PCL / Eigen)
- ROS-ified viewer (:: octovis2)
:: octomap2  |  Runtime optimization

- Substitute floating-point by integer operations
- Code optimization
- SSE optimization
:: octomap2  |  Real-time 5D-mapping

2cm map resolution, 5Hz stereo updates
:: collider

- Collision map module
- Probabilistic map (octomap2)
- Represents freespace and unknown
- Sensor fusion (laser, stereo)
- Per-voxel timestamps
  - Clearing of outdated voxels
- Will be part of :: pr2_arm_navigation
:: collider | sensor fusion
:: collider  |  clearing outdated cells
Semantic Mapping
 Hierarchical Map

- High-resolution object maps (e.g., 2 mm)
- Coarser models for other classes (e.g., 2 cm)
:: object_mapping

Room 01

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<thead>
<tr>
<th>Table 01</th>
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<td>Obj 01</td>
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:: object_mapping  |  object maps
:: object_mapping  |  outlook

- **Autonomous** object mapping (exploration)
- Hierarchical mapping system will be merged into :: octomap2
  
  ➡️ octomap/h  (octomap / hierarchical)
ROS Module Overview

sandbox
:: mapping3d / :: mapping_tools
:: collider

pointcloud_experimental
:: octomap2 / :: octovis2
:: object_mapping
Thank you!