Modeling the World Around Us

An Efficient 3D Representation for Personal Robotics

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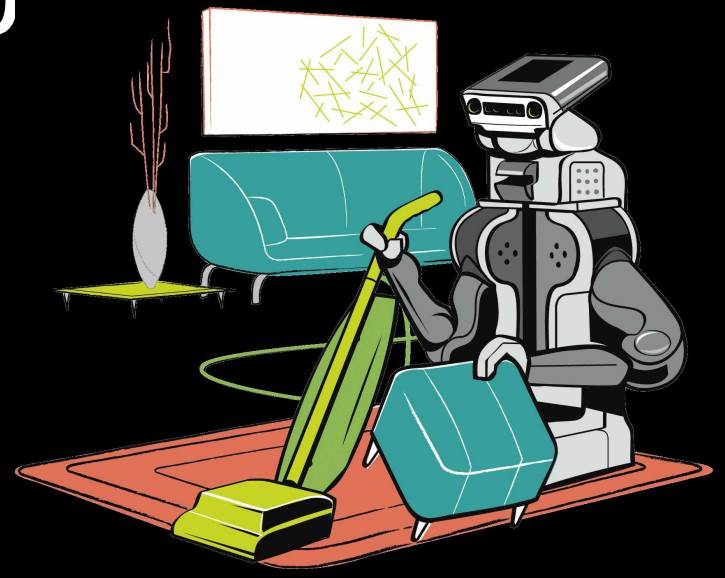
Personal Robotics

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



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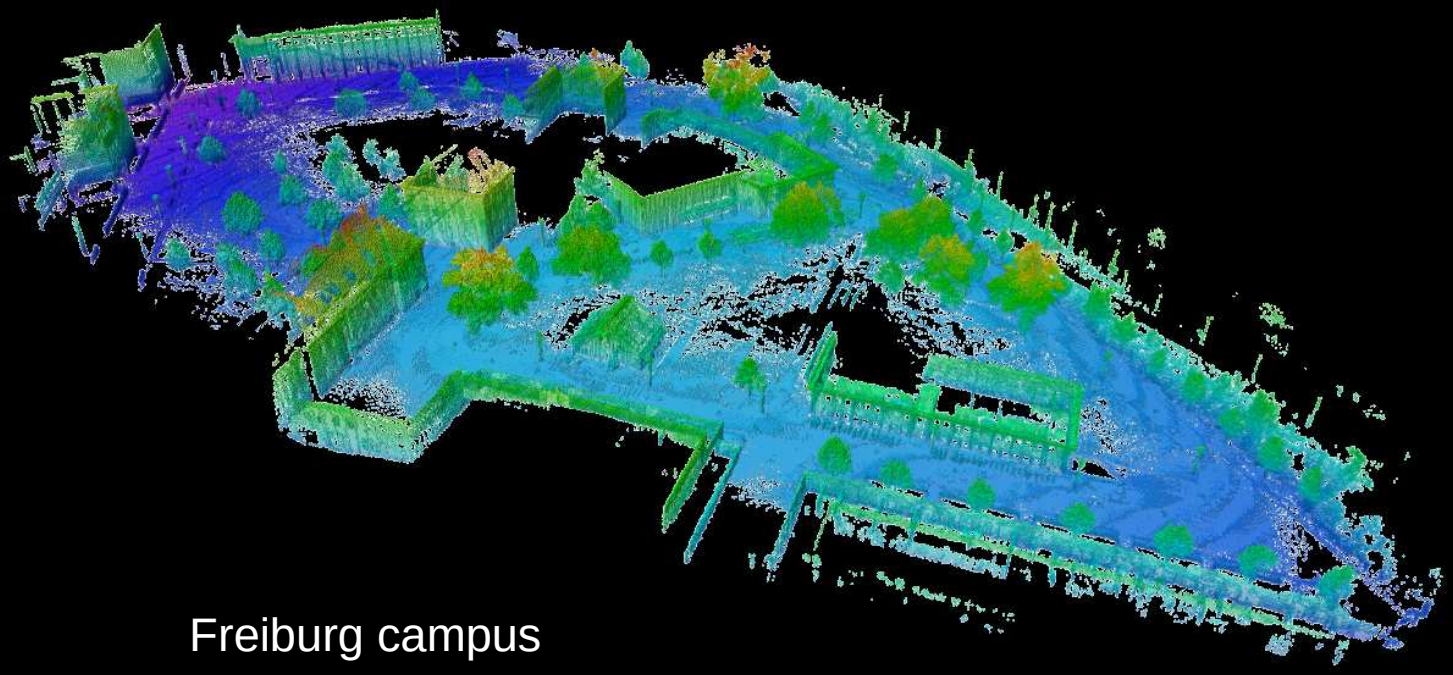
Challenges for Mapping

- 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  - Clear outdated information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

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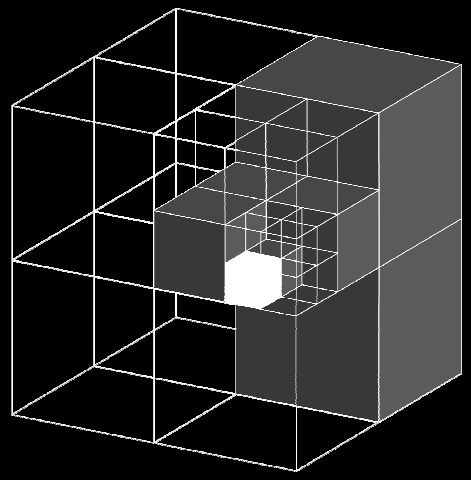
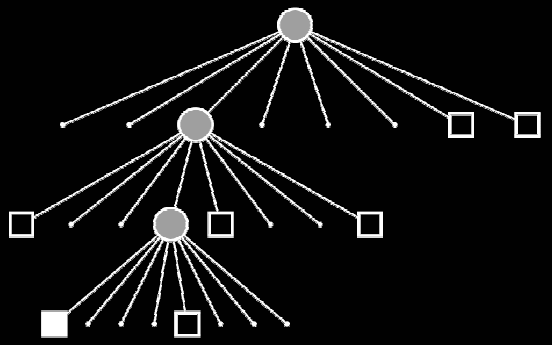
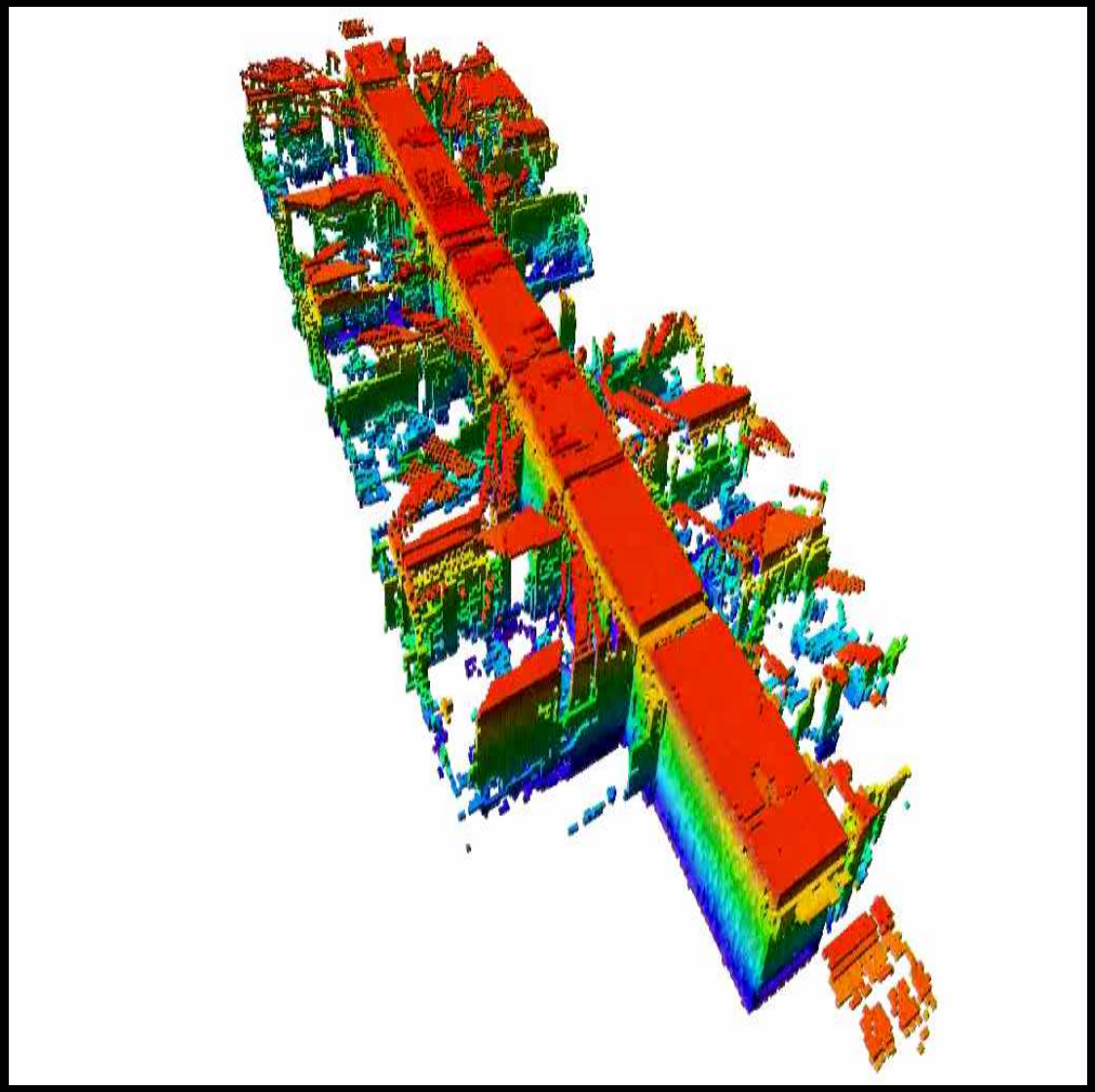
:: octomap



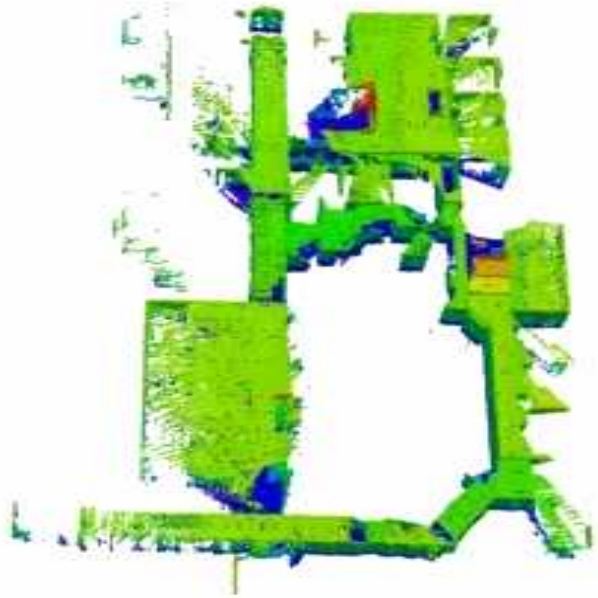
- Probabilistic 3d mapping framework
- Based on octrees
- Optimized for memory efficiency



- Open source, BSD licensed



Freiburg, building 079



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:: 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**

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Collision maps for mobile manipulation

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:: octomap2

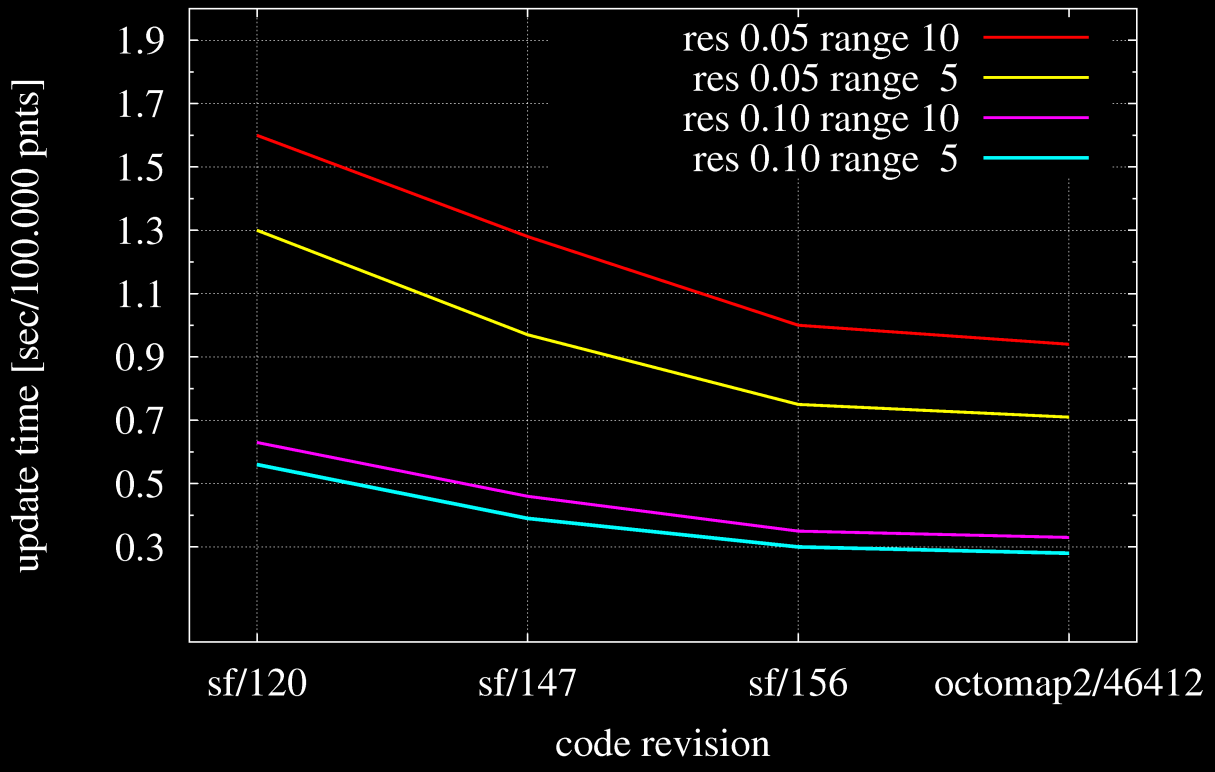
- Optimized for online operation
- Optional per-voxel timestamps
- Supports hierarchical mapping

➡ 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



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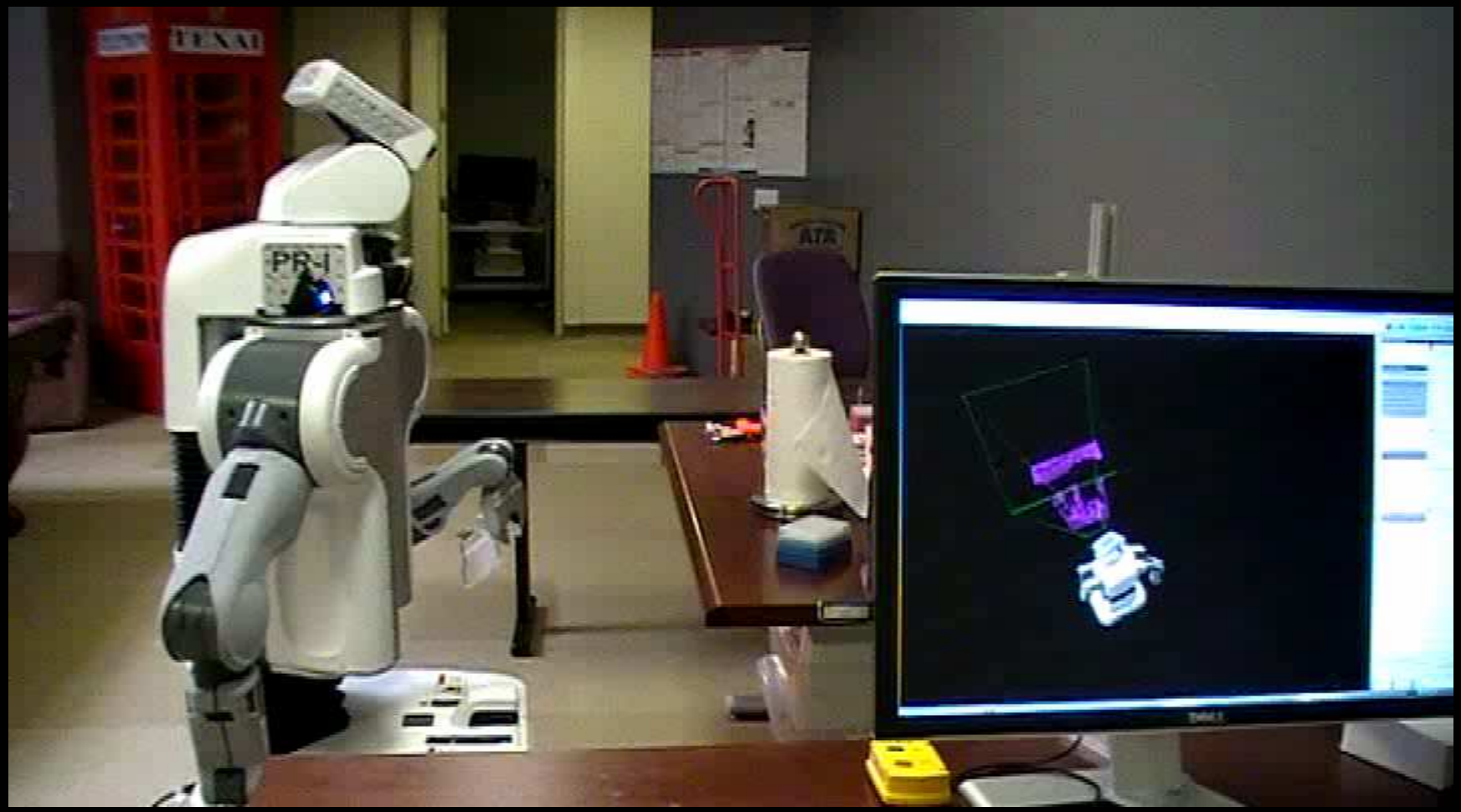
:: **octomap2** | Real-time 5D-mapping



2cm map resolution, 5Hz stereo updates

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:: 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

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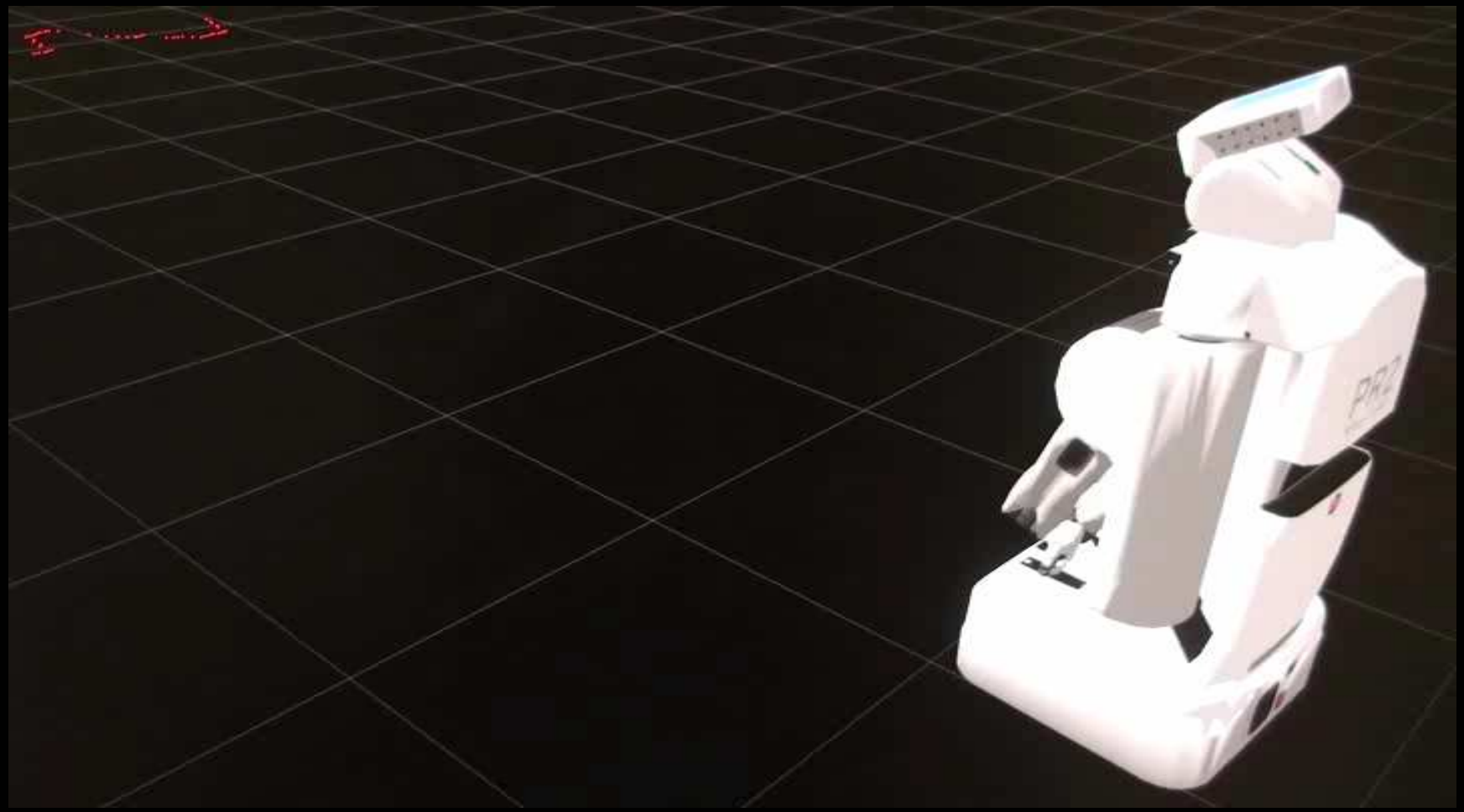
:: collider | sensor fusion



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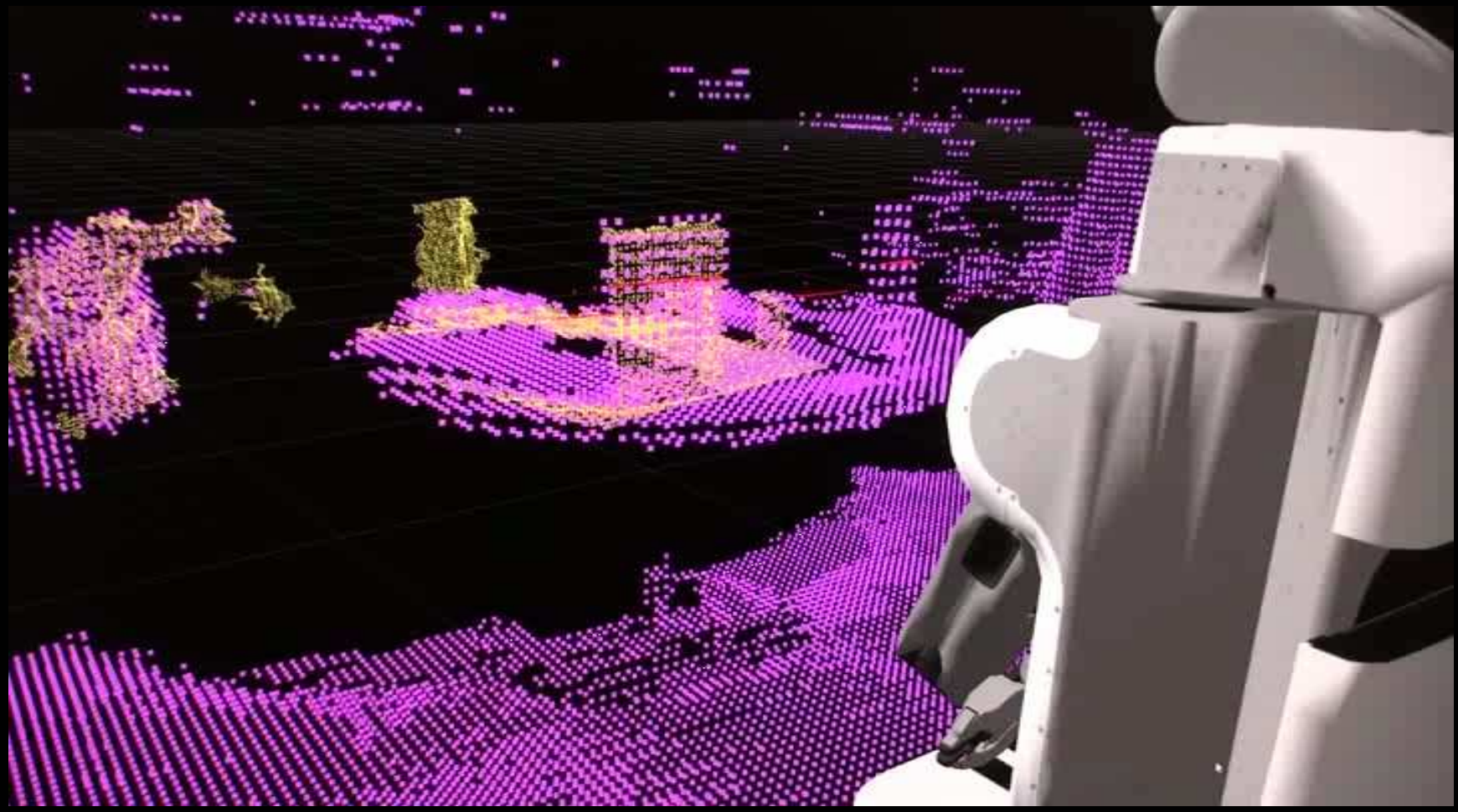
:: collider | clearing outdated cells



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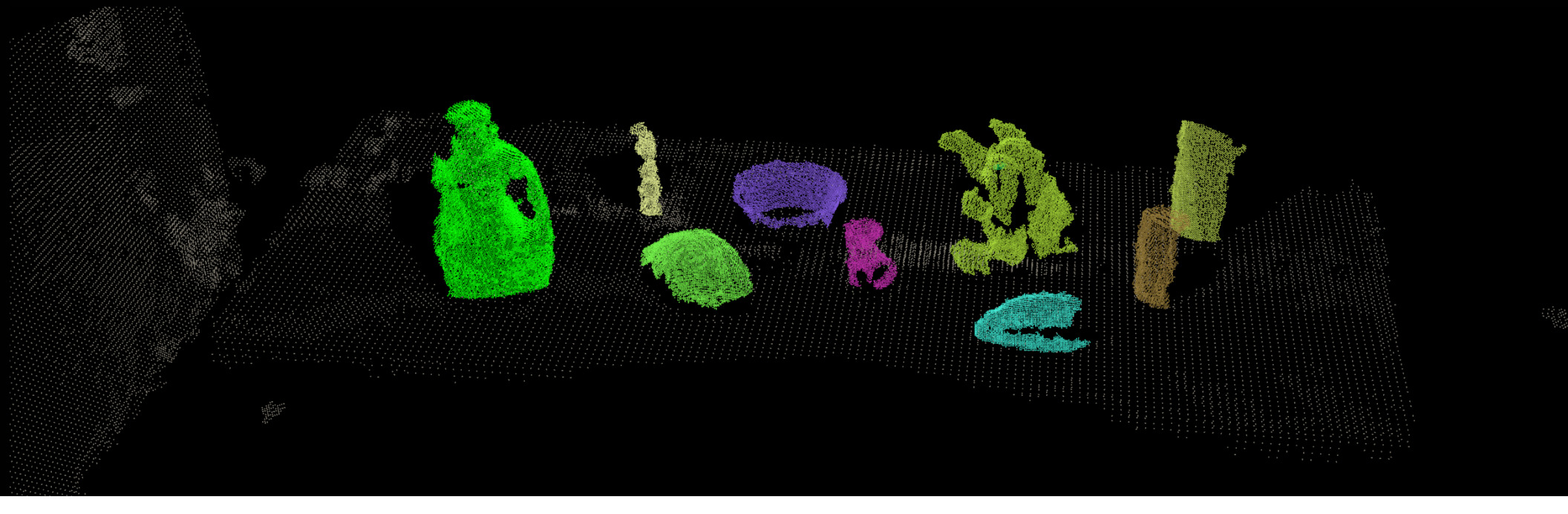
Semantic Mapping



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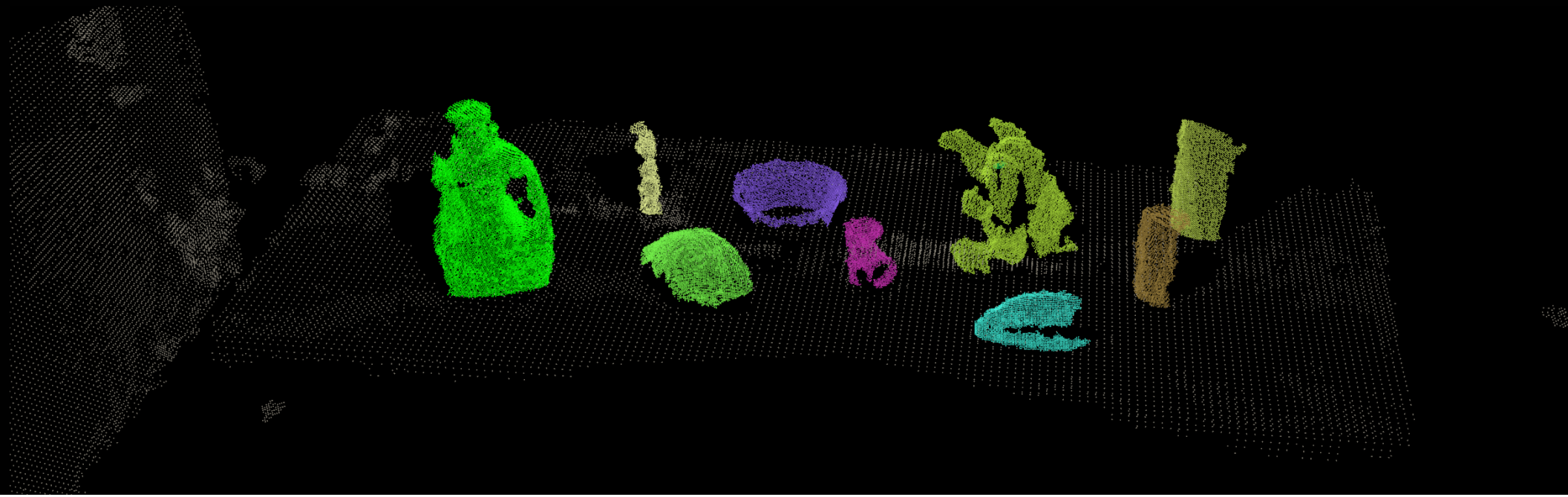
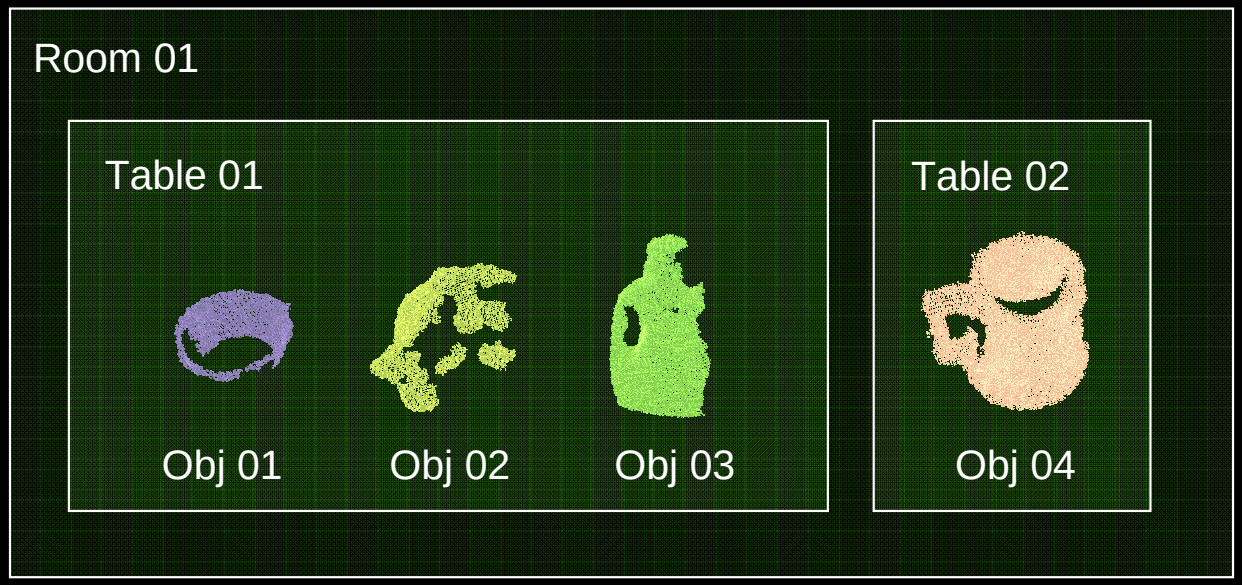
:: object_mapping

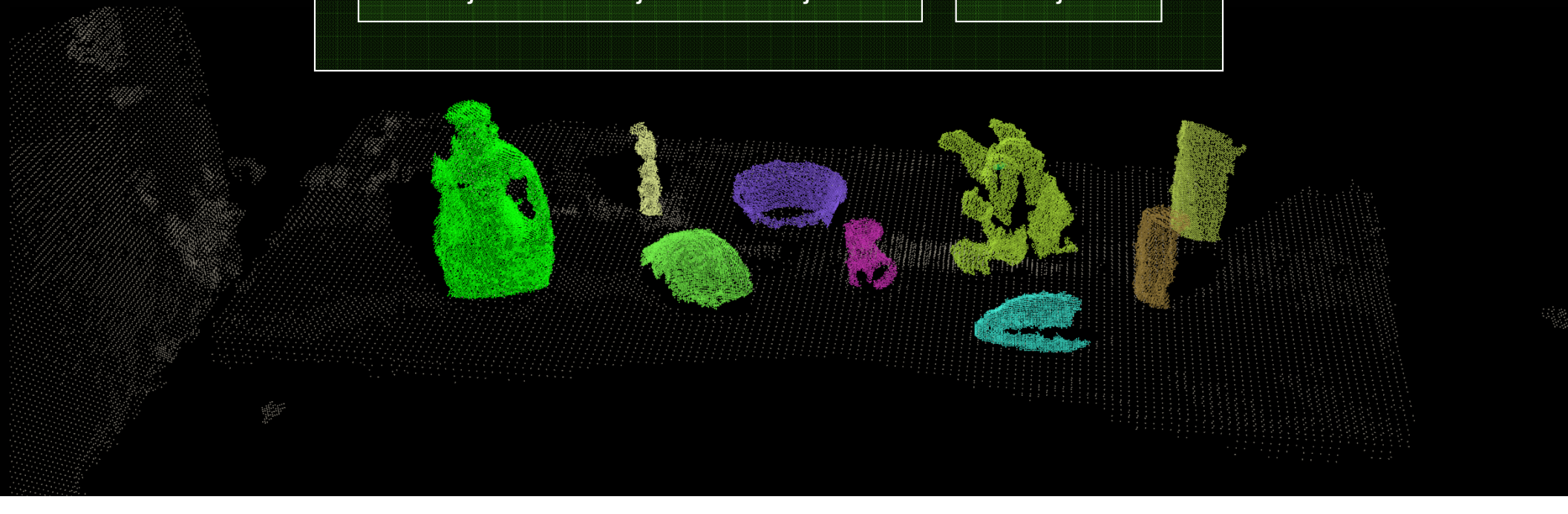
Hierarchical Map

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



:: object_mapping





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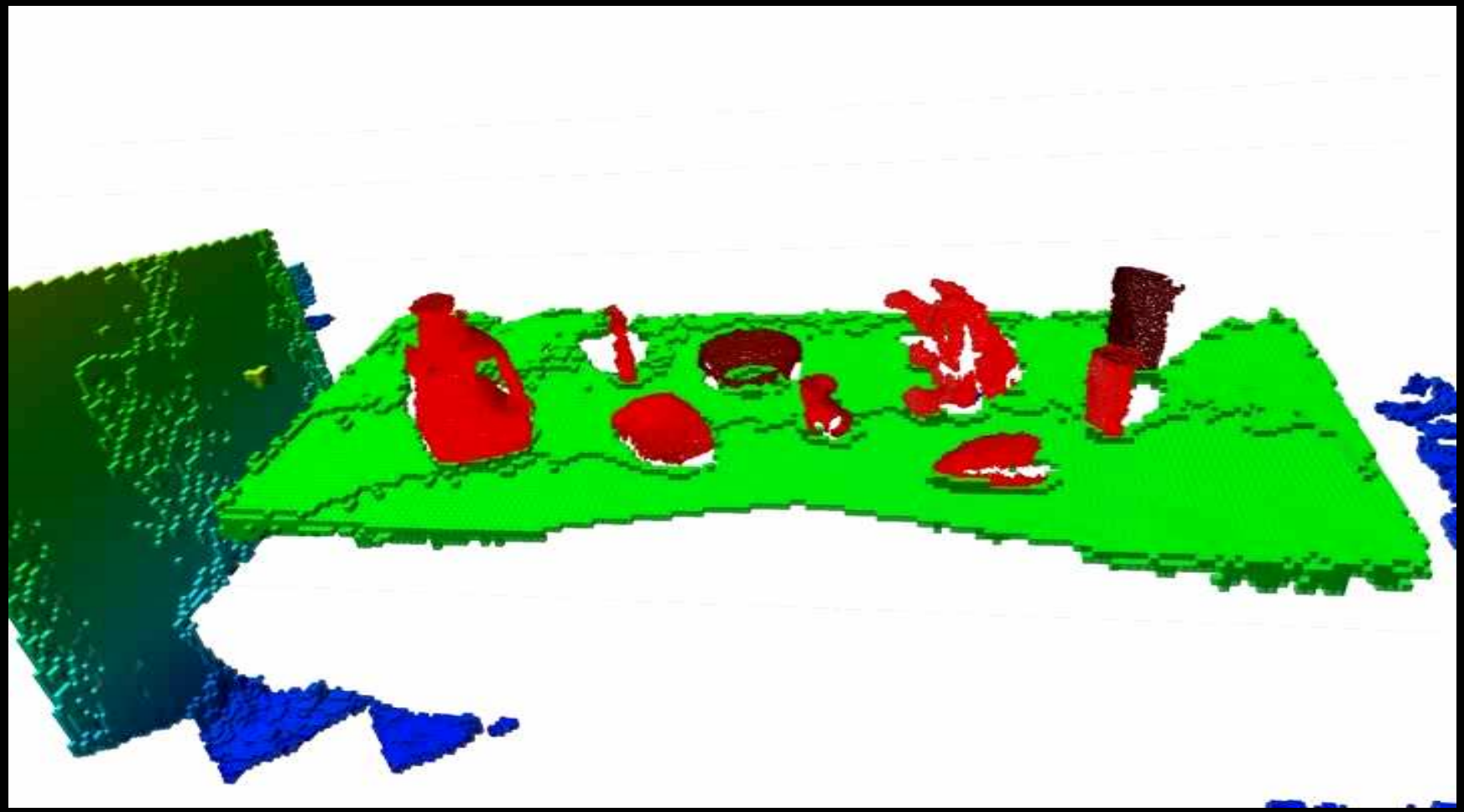
:: object_mapping | object maps



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:: 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!