# PCL Hackfest Summer 2016

## Extensions and applications of pcl::sample_consensus

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DLR

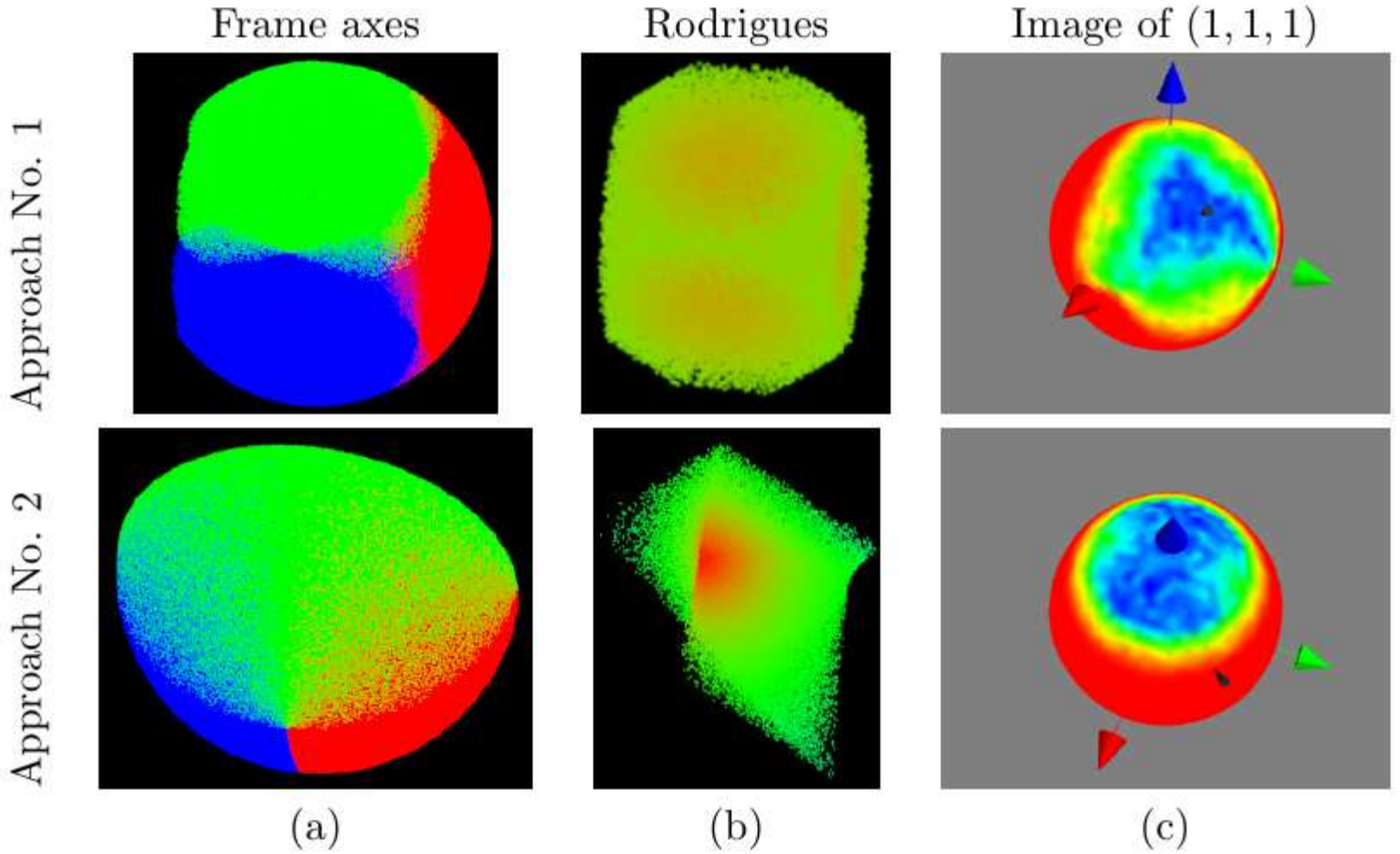
# PCL @ DLR

- Several users, especially in the mobile robotics group, mainly in conjunction with ROS
- Sometimes ROS/PCL used as benchmark against own methods
- However, there is some development as well, mainly in the sample consensus module:
  - New shape models (to be committed to PCL soon)
  - New scoring and an intuitive user interface (published, but no code)
  - Parallel RANSAC, RJ-MCMC, etc, GSoC code to be integrated...

# New Shape Models

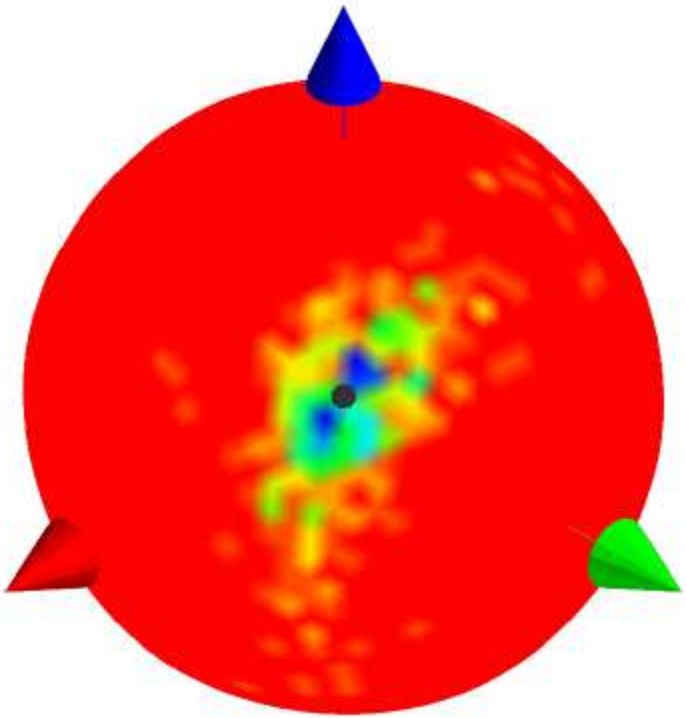
- Manhattan frames: principle orientation axes
- Cuboid/box: RANSAC-like extension of the Manhattan frames
- Torus
- Surface of revolution
- Polynomial surface model

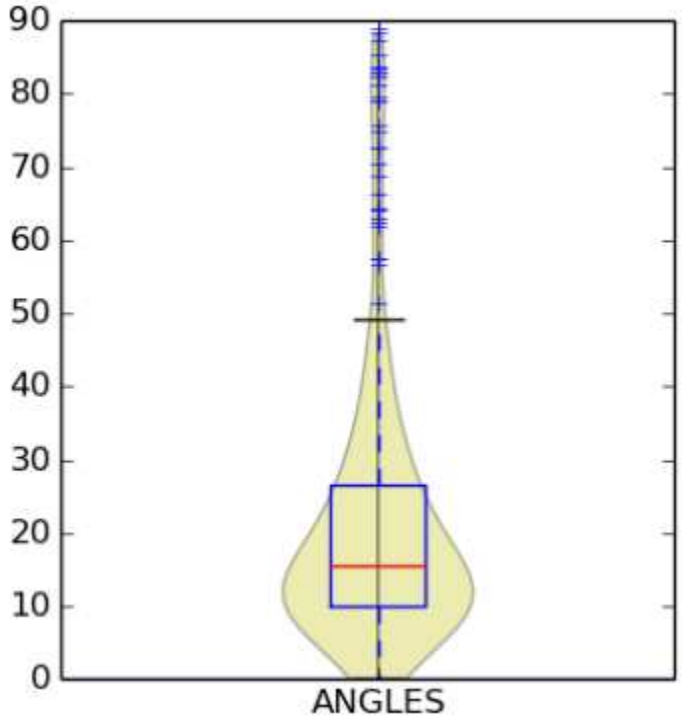
# Manhattan Frame / Orientation




# Manhattan Frame / Orientation

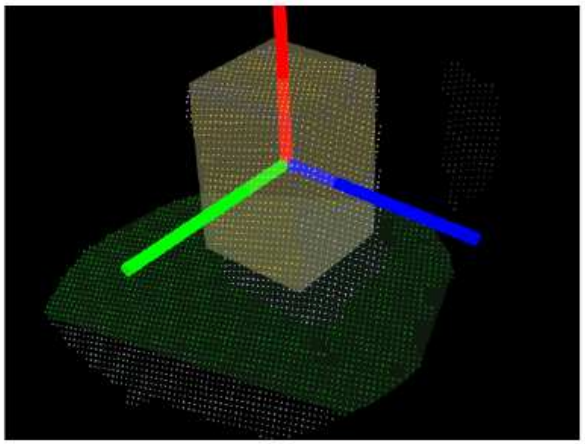
- Comparison to [Straub et al. CVPR 2014]:



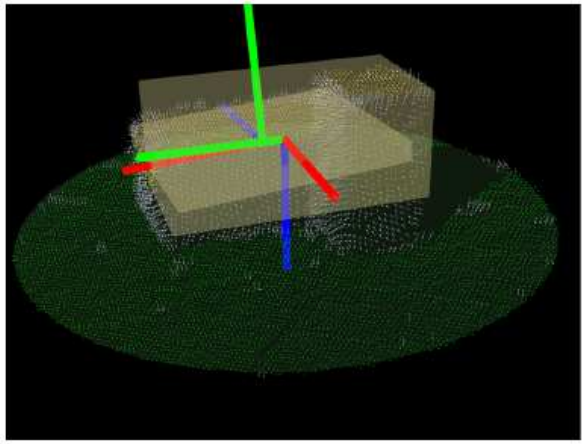



# Cuboid / Box

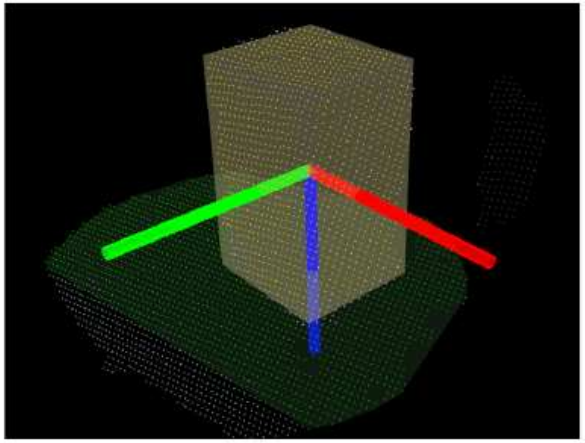
- Sampling two points with normals
- If they come from the same side then only a rectangle is fitted (OBB)
- Perpendicular sides define the box, but using inliers for the estimation of extents improves results a lot



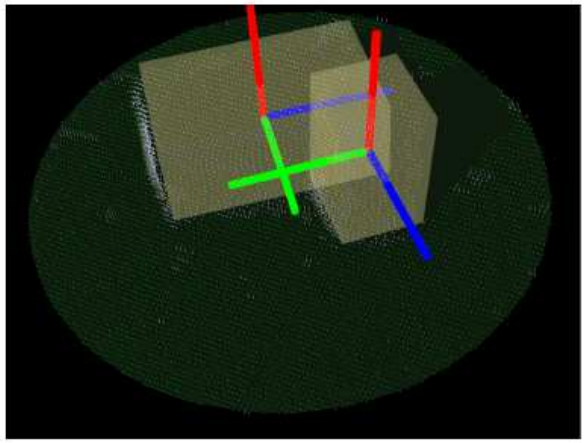
(a) One box on a table - RANSAC version



(b) Two boxes on a table - RANSAC version



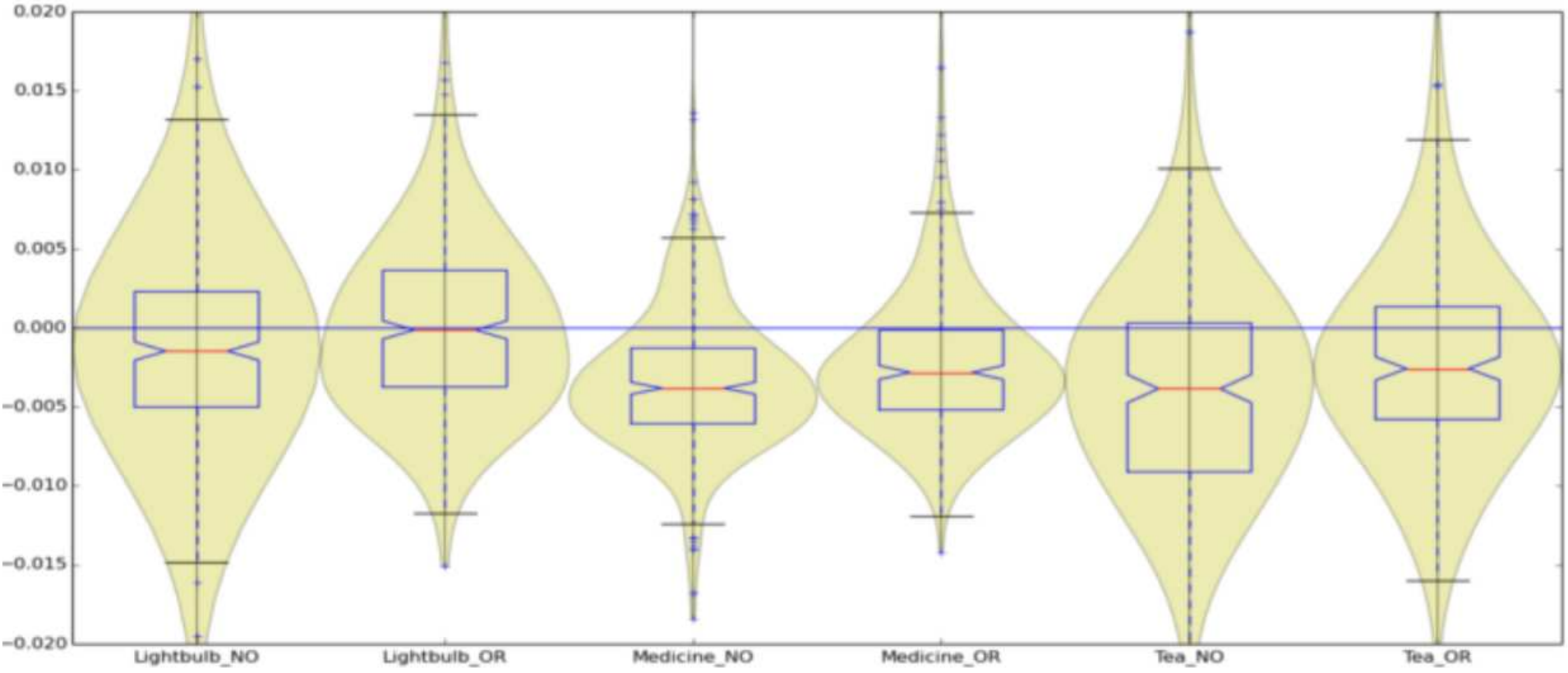
(c) One box on a table - RANSAC-like version



(d) Two boxes on a table - RANSAC-like version

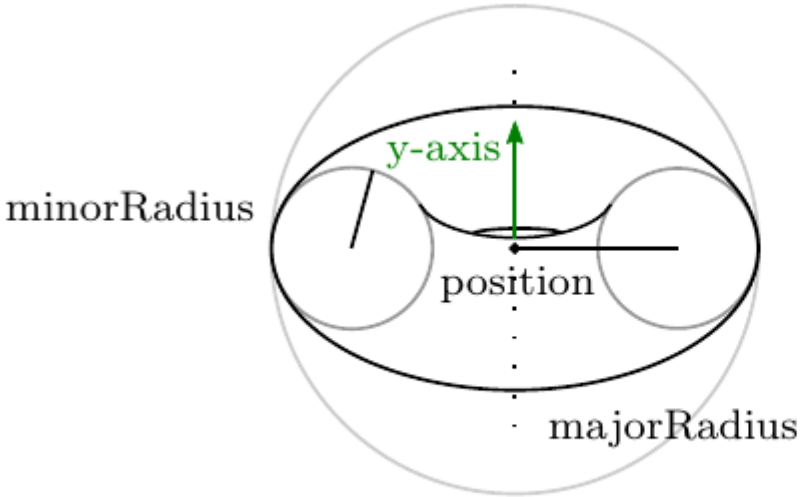
# Cuboid / Box

| | RMSE [m] | | Mean time [sec] | | Mean nr. | Nr. of |
|---|---|---|---|---|---|---|
| *occlusion rating:* | *no* | *yes* | *no* | *yes* | of points | views |
| Lightbulb box | 0.0352 | 0.0147 | 0.681 | 1.081 | 12352.9 | 10 |
| Medicinal tea box | 0.0105 | 0.0102 | 0.551 | 0.568 | 12648.8 | 9 |
| Black tea box | 0.0248 | 0.0197 | 0.496 | 0.592 | 11484.7 | 6 |

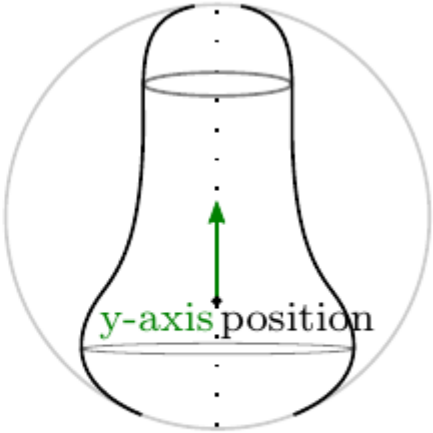


# Torus and Surface of Revolution

- Re-implementations from literature
- Surface of revolution based on [Blodow et al. Humanoids 2009]



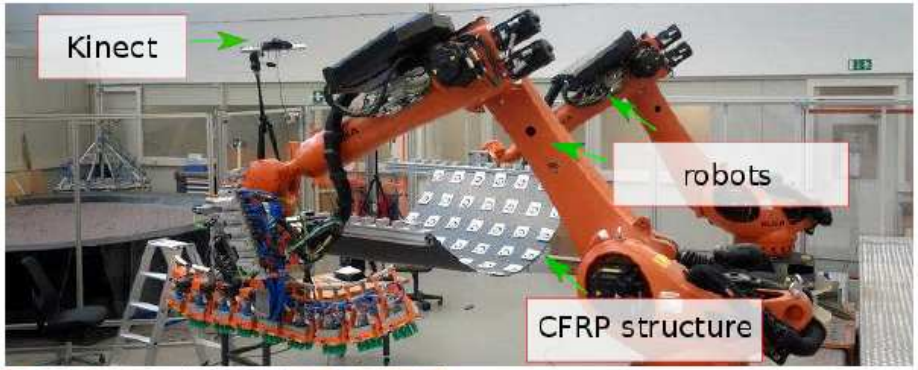

Torus

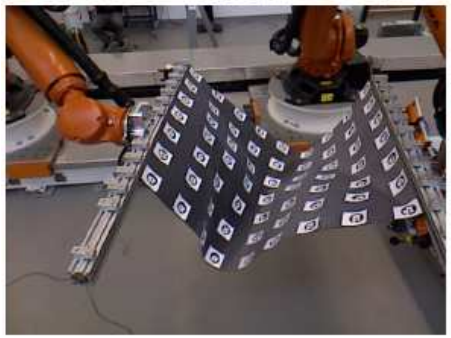


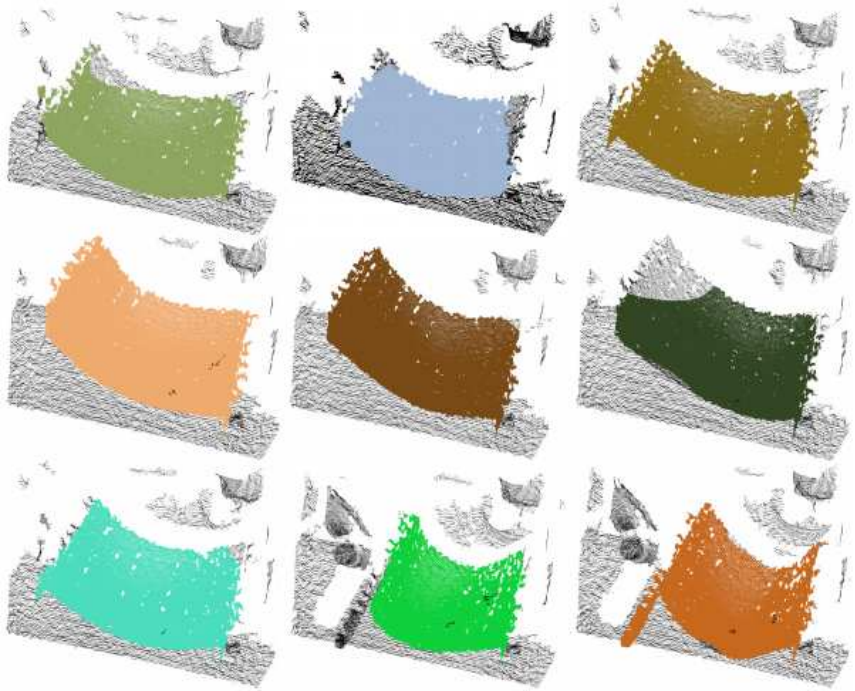

Surface of Revolution

# Polynomial Surface Model

- Bi-variate polynomial fitting like in MLS, but with RANSAC sampling
- Reducing the polynomial order EM-style, see [Nissler et al. IROS 2013]





# Intuitive User Interface

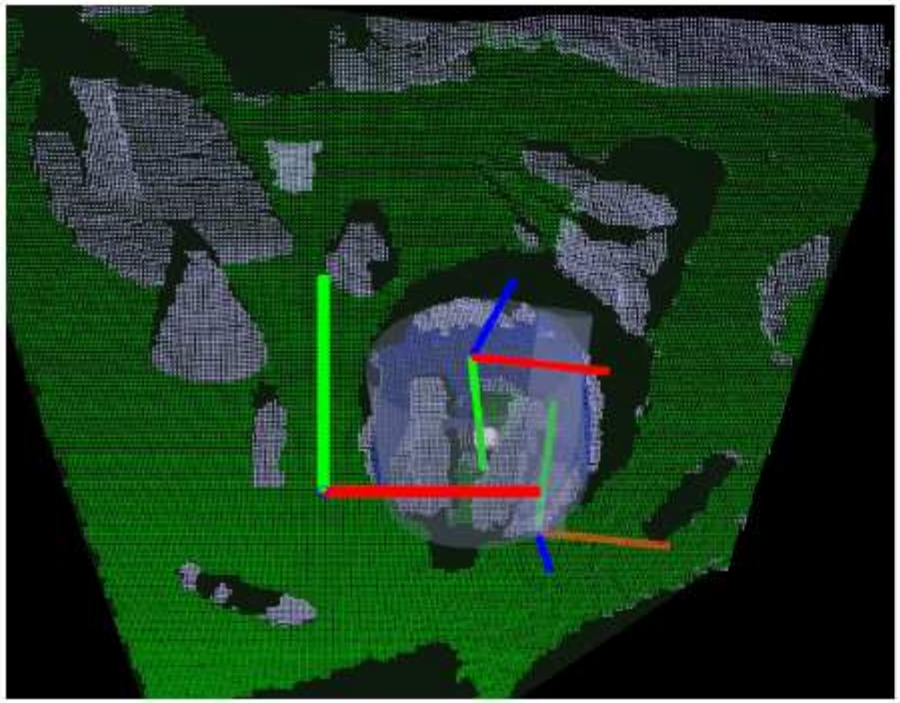
- Human-readable scene parsing language based on ANTLR:

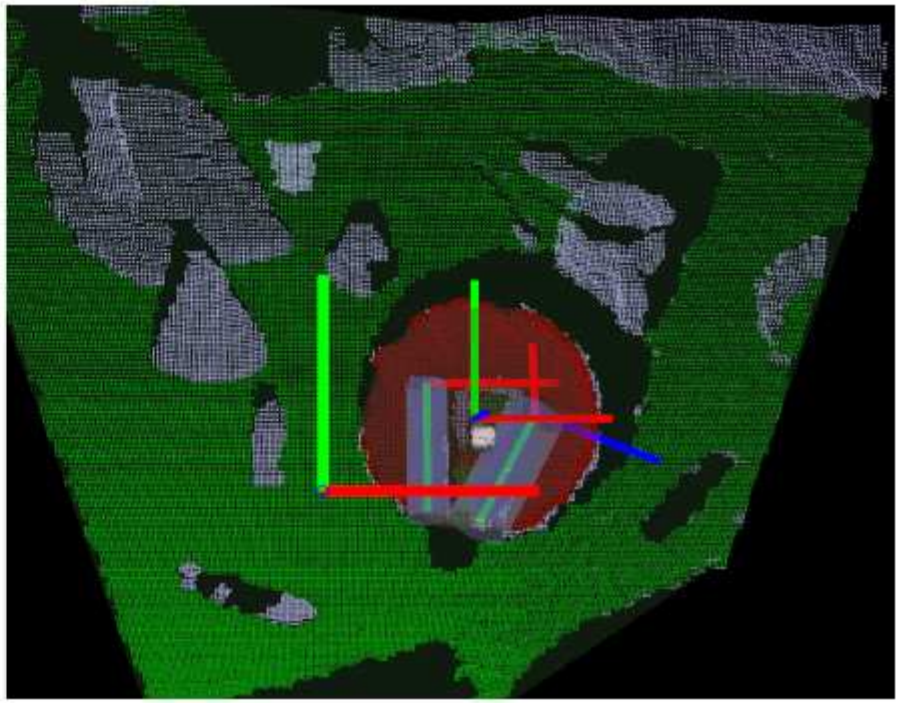
```
1  plane "table"
2  ...
3  volume "tabletop": outside of "table"
4  ...
5  sphere "lampshade" in "tabletop" precluster 0.02 600 10000
6  radius: [0.05 - 0.1]
7  ...
8  volume "lampshadeInterior" : inside of "lampshade"
9  ...
10 cylinder "handle1" in "lampshadeInterior" precluster 0.01 100 10000
11 radius: < 0.02
12 ...
13 cylinder "handle2" in "lampshadeInterior" precluster 0.01 100 10000
14 orientation: y parallel to an axis 15 degrees off "table".y-axis ~ 15
15 ...
```

- See [Büttner et al. RAM 2016] (in the PCL special issue), holds also the previous model and scoring descriptions and their evaluations

# Intuitive User Interface

- With and without hierarchic approach:

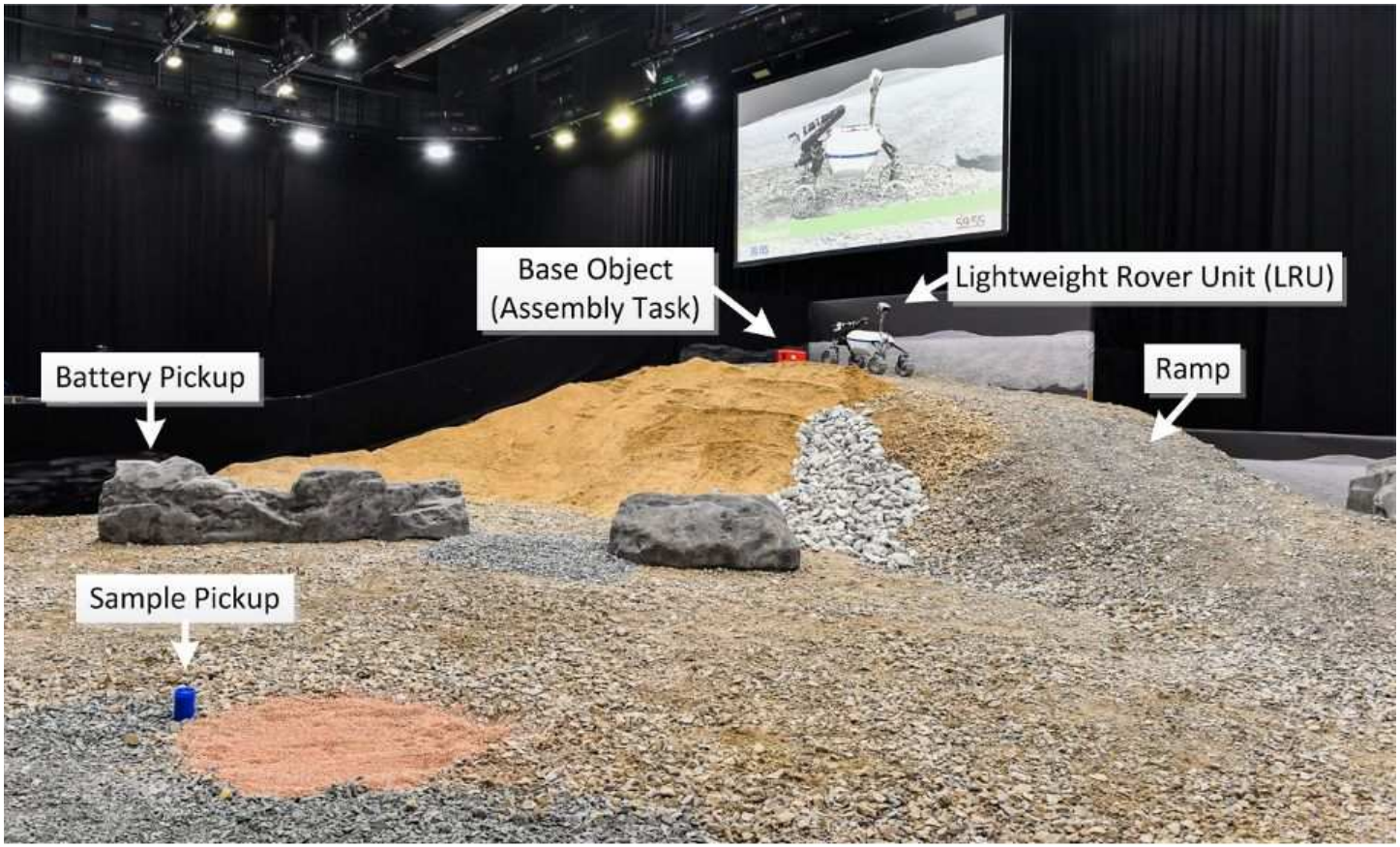




- Easy definition of processing graph: faster programming and execution

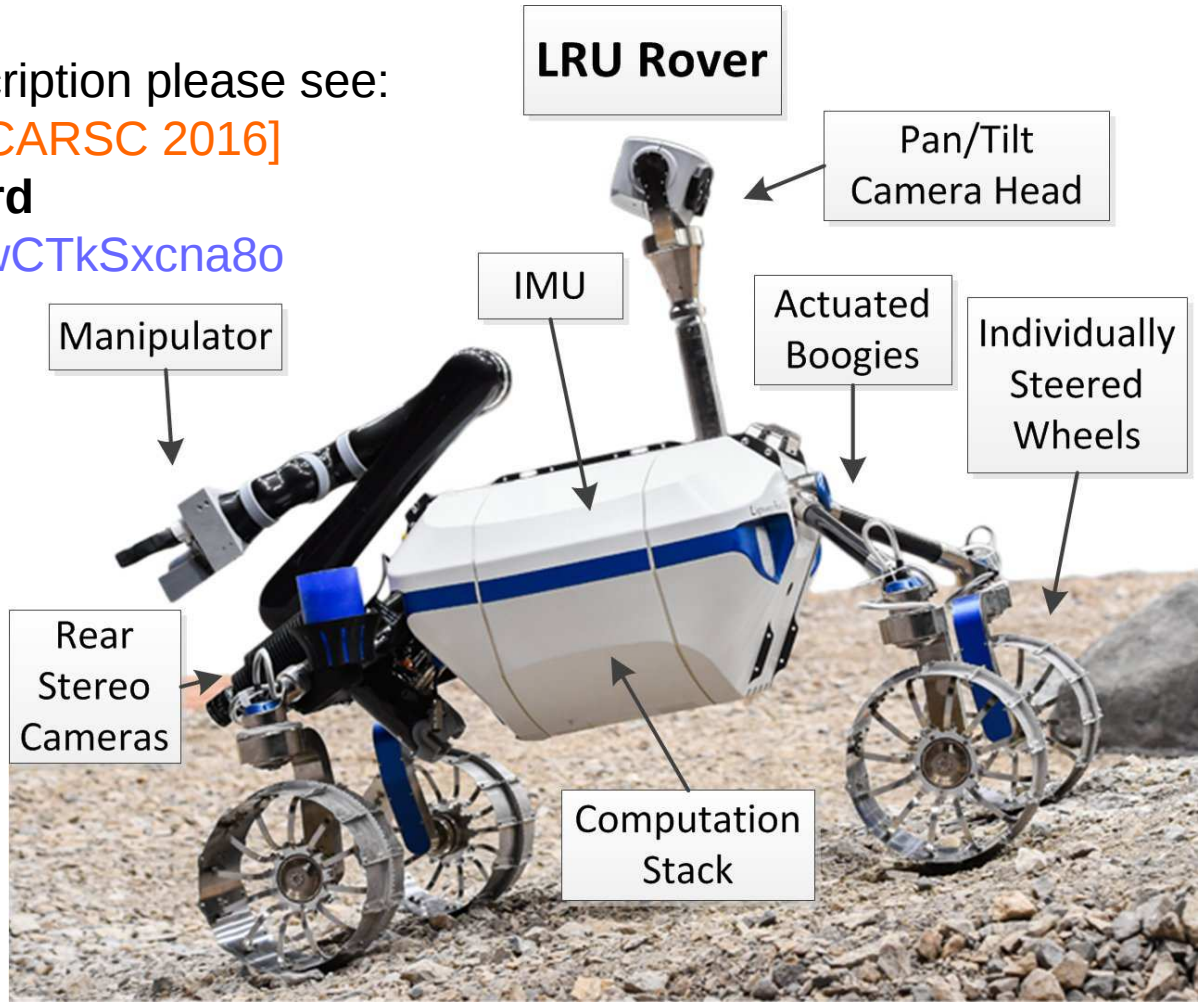
# Application: pose estimation in SpaceBot Camp

- Symmetric shapes, with specific constraints, partial visibility



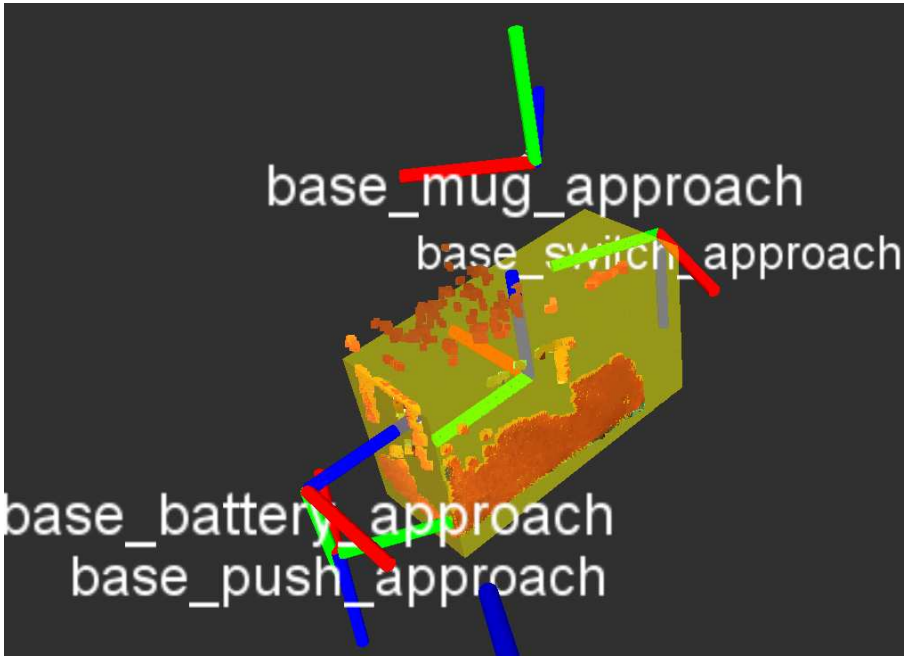

# Application: pose estimation in SpaceBot Camp

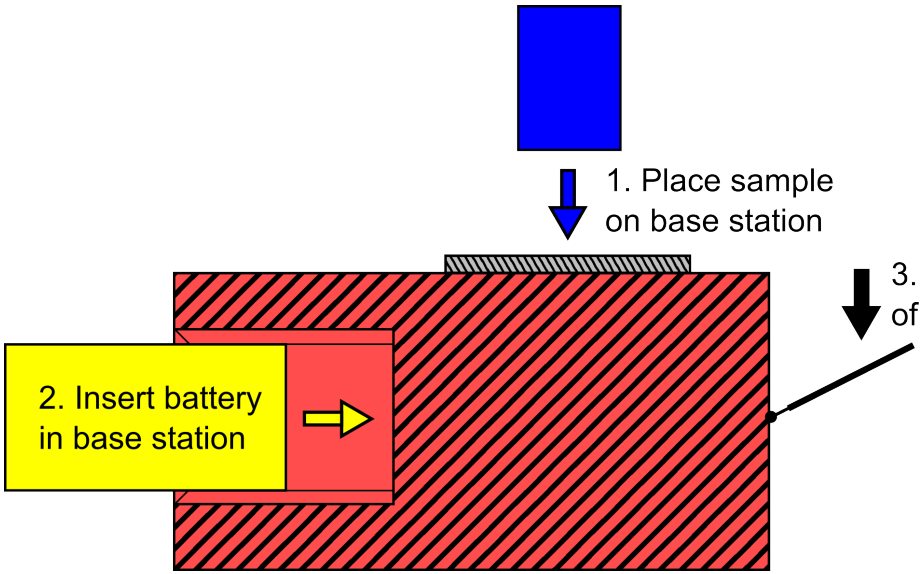
- For detailed description please see:
  [Schuster et al. ICARSC 2016]
  **Best paper award**
  https://youtu.be/wCTkSxcna8o
  (fun at 4:54 ☺)




# Application: pose estimation in SpaceBot Camp

- Stereo data using a laser-projected pattern
- Missing points and occluded, outside of FoV regions




- Using occlusion rating
- Fitting of original-size model (3D and 2D verification steps)

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# Thank you for your attention!

# Any questions?