



Mobile Manipulation in Service Robotics: Scene and Object Recognition with Manipulator-Mounted Laser Ranger

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Outline

- Motivation
- System Overview
- Scenario Description
- Method
 - Object Recognition
 - Collision free Path Planning
- Conclusions
- Video/Questions





Motivation

- Manipulation of objects is essential in service robotics.
- Embed manipulation in a complex scenario.
- Make manipulation component robust.



System Overview

Hardware

- Pioneer P3DX
- SICK LMS 200
- Neuronics Katana arm
- HOKUYO URG-04



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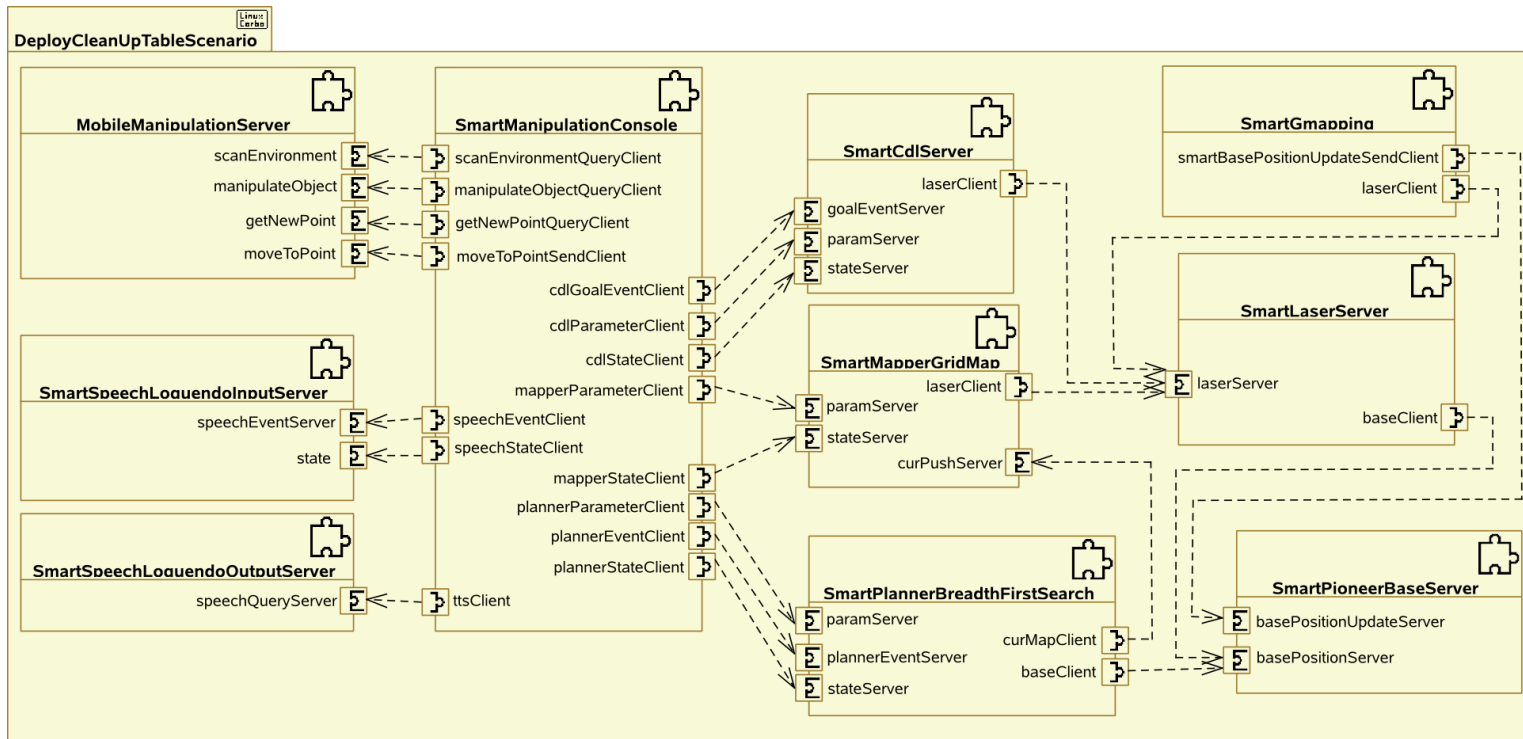




System Overview

Software

- SmartSoft Components and Toolchain for Robotics



Scenario Description



Operator gives
robot the cleanup
command

Robot drives
to the table



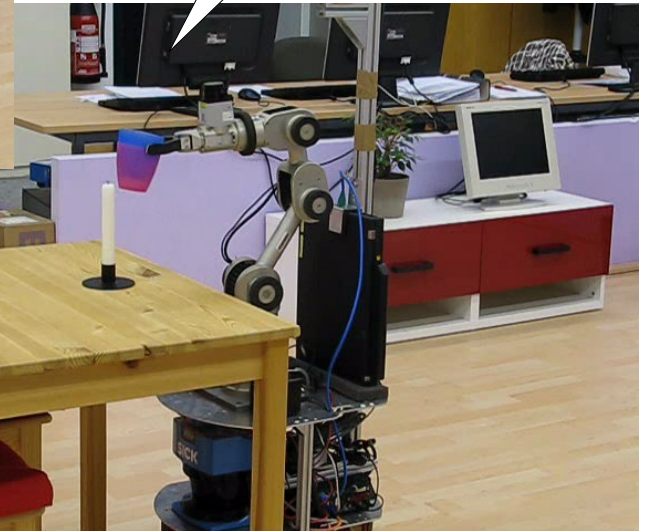
Robot scans the
table with the
laser ranger

Scenario Description

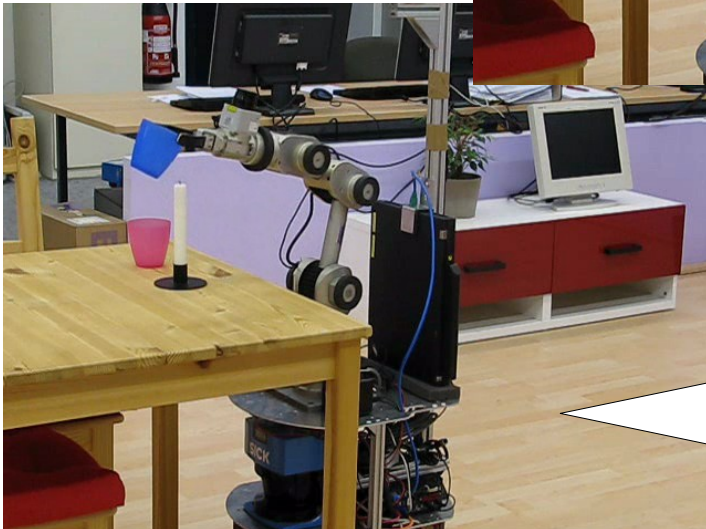
Robot grabs first cup



Robot grabs both cups



Robot stacks first cup in second cup



Scenario Description

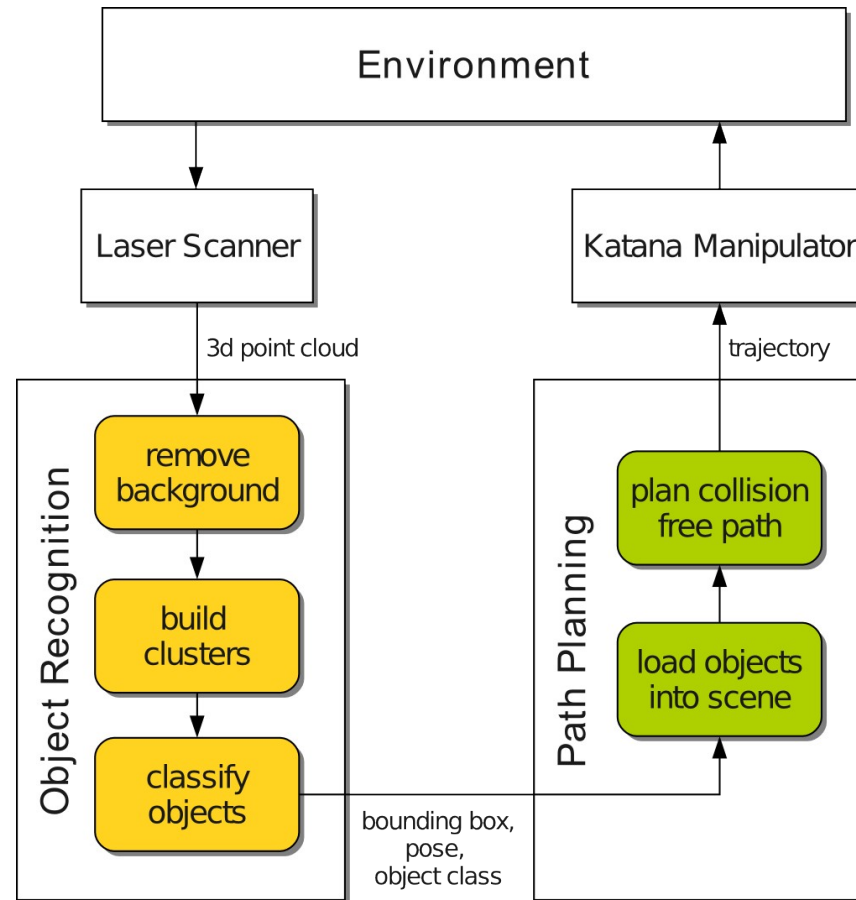


Robot drops both cups
into the trash bin

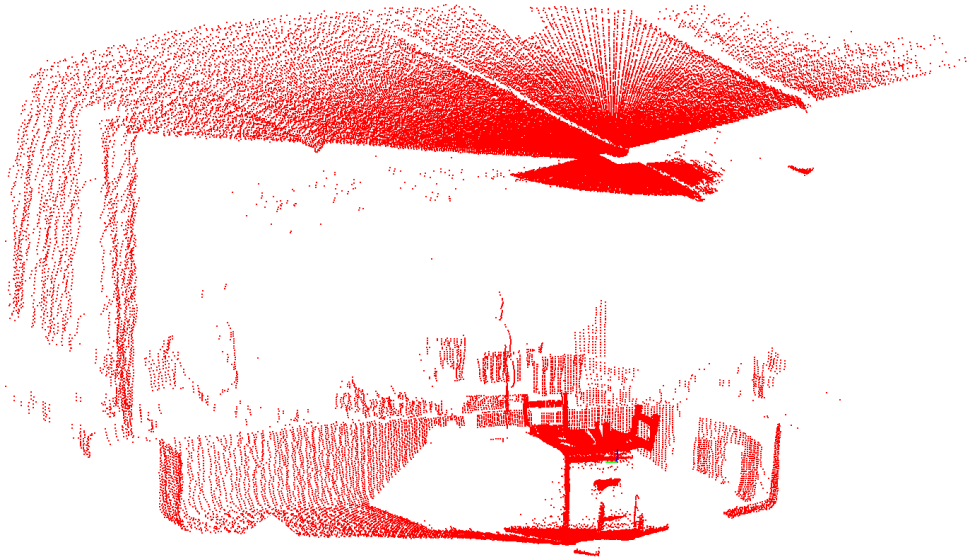


Robot drives back to
the operator and
reports the success

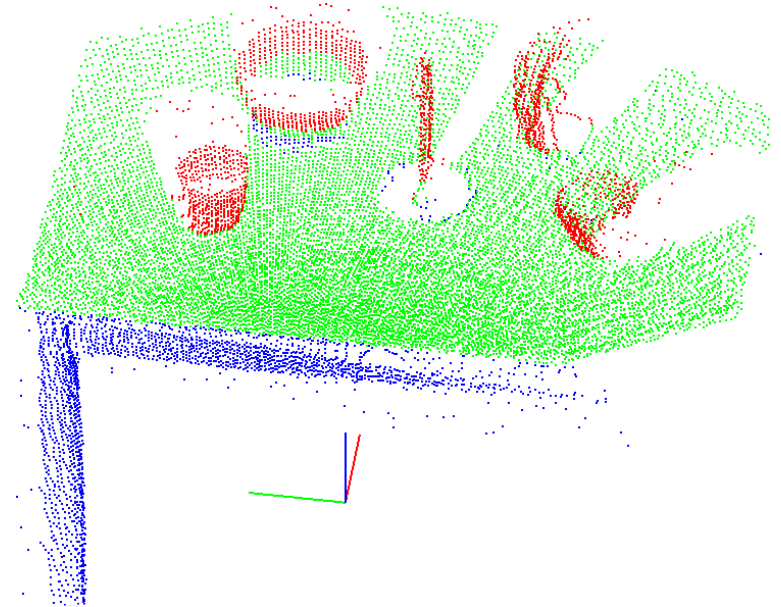
Overview



Object Recognition



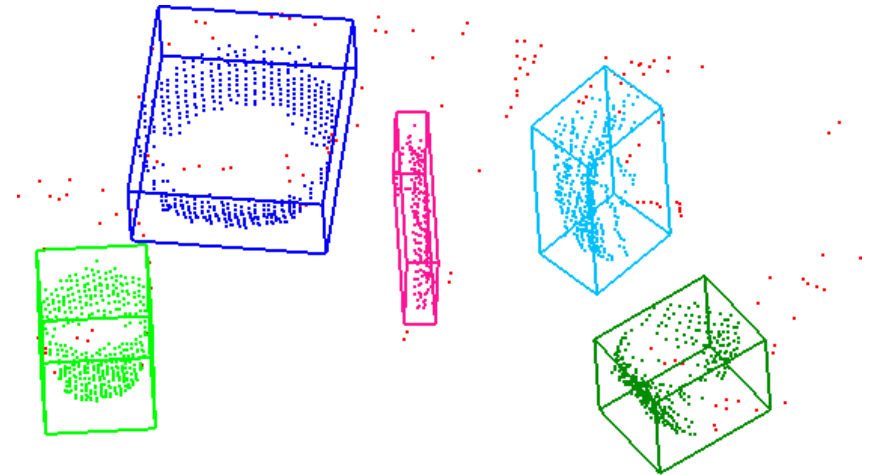
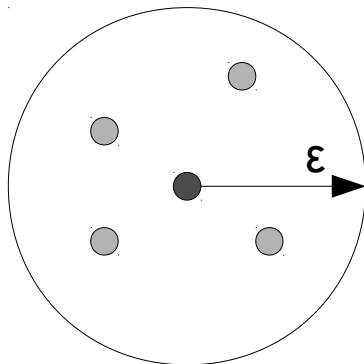
about 150,000 points,
max distance 5.6 m



about 30,000 points,
workspace 0.7 m,
table plane detection
with RANSAC

Object Recognition

- Clustering is done with **DBSCAN** (**D**ensity-**B**ased **S**patial **C**lustering of **A**pplications with **N**oise)
- Density is defined by *minPts* and ϵ .



about 5,000 points



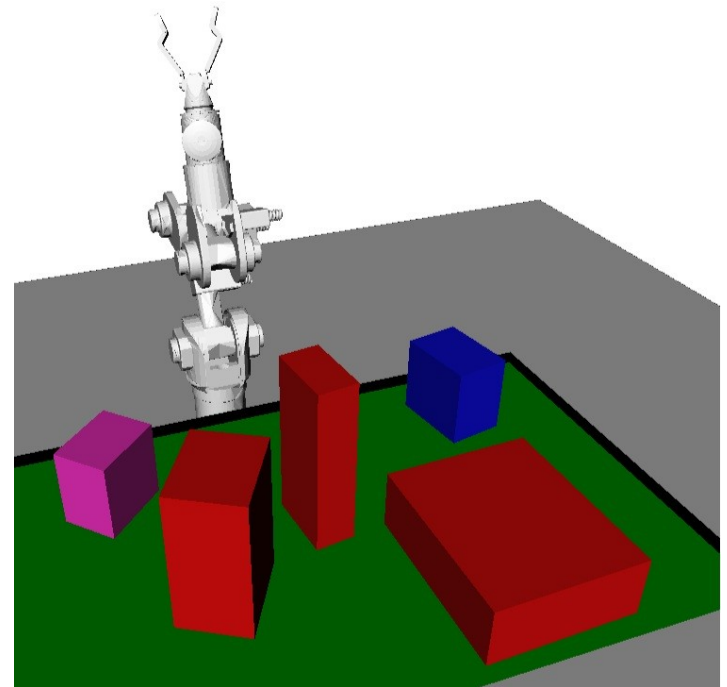
Object Classification

- Calculate features (dimensions, curvature, ...)
- Set of features form a *feature vector* in a *feature space*.
- Several *feature vectors* of an *object class* form a multidimensional probability distribution.
- A unknown object belongs to an *object class* if the Mahalanobis distance between the *feature vector* and the probability distribution is smaller than a defined value.
- The max distance value can be determined using the Chi-square distribution.



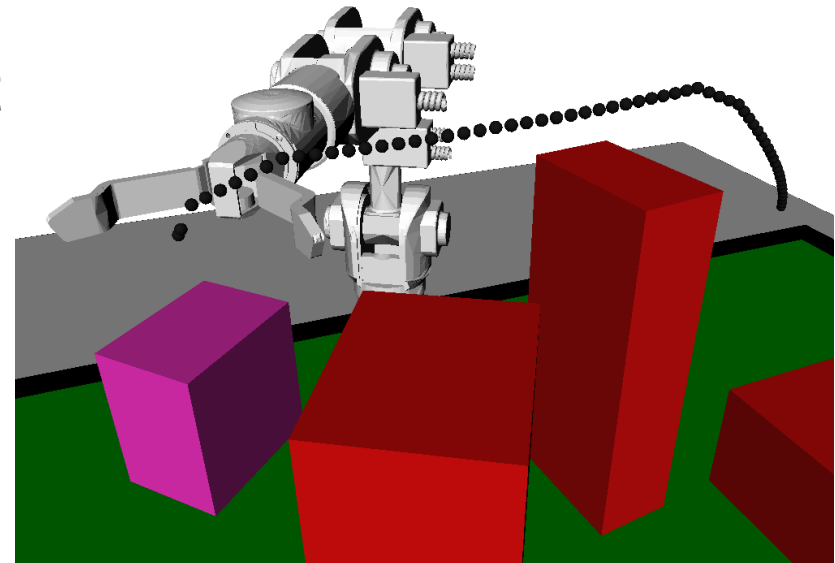
Collision free Path Planning

- OpenRave for collision free Path Planning.
- Katana was thus modeled in OpenRave.
- Katana arm is represented as a mesh.
- Objects are model as boxes at the moment.



Collision free Path Planning

- The contour of the arm is considered while planning.
- If an object is in the gripper it is also considered.
- Planned path consists of about 200 points.





Conclusion

- Whole scenario was run about 40 times in the ZAFH laboratory at the University of Applied Sciences Ulm.
- Only one failure when the two cups tumble down while stacking them into each other.
- Used in the RoboCup@Home in Magdeburg in the Open Challenge and Finals.



Video/Questions?

- <http://www.zafh-servicerobotik.de/en>
- <http://smart-robotics.sourceforge.net>
- <http://youtube.com/user/roboticsathsulm>



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