Localizing Grasp Affordances in 3-D Point Clouds Using Machine Learning

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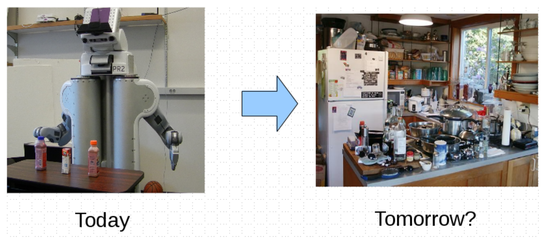
Motivation

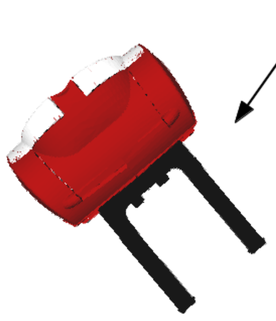
- Perception-for-grasping
- Unstructured and novel environments
- Inexpensive and accurate range sensors
- Own previous work restricted to enveloping grasps



Today Tomorrow?

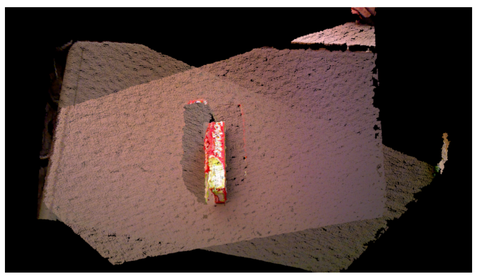
Problem Statement

Find all configurations where this hand



... grasps an object in this scene.

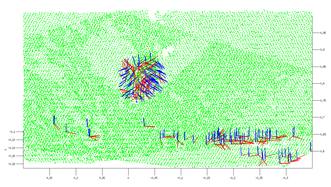
- Input: point cloud



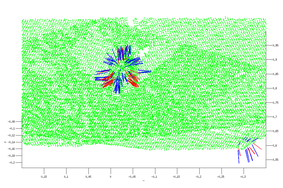
- Output: a set of valid grasp hypotheses

Approach

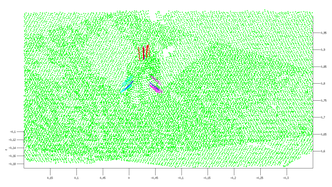
1. Constrain search space by aligning grasp with principal curvature axis.
2. Filter out geometrically impossible grasp hypotheses.
3. Use machine learning to eliminate additional unlikely grasp hypotheses.
4. Identify aligned grasp hypotheses.



(a) Curvature Axes and Normals



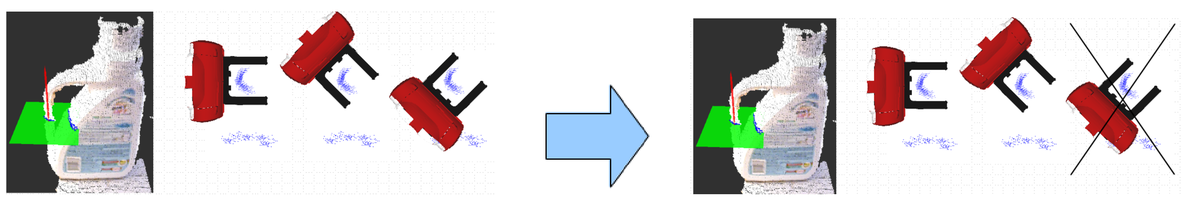
(b) Classified Graps



(c) Aligned Grasps

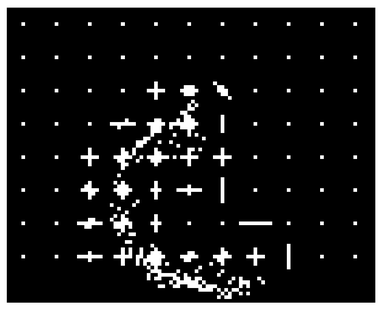
Filtering Grasp Configurations

- Constrain grasps to be orthogonal to the curvature axis
- Filter out impossible grasp configurations based on cloud geometry



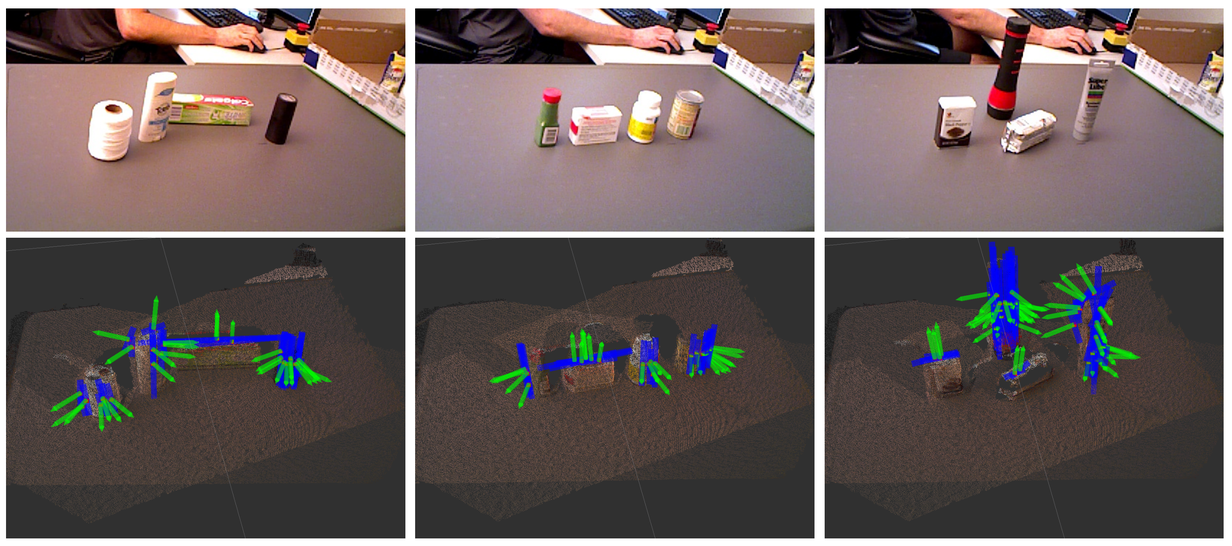
Recognize Good Grasps

- Use machine learning to recognize good grasps
  - SVM classification of good grasps
  - Encode grasp ”images” using HOG features
  - Training data: manually labeled grasps on a set of objects



Localization Results: Single Objects

Localization Results: Multiple Objects

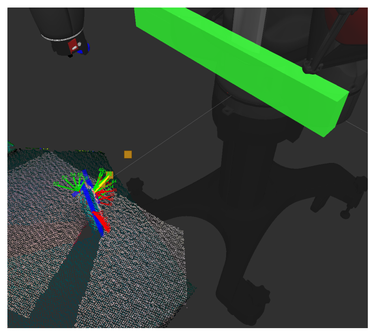


Robot Setup

- Robot: Rethink’s Baxter
  - Two 7-DOF arms
  - Two RGB-D cameras attached to a self-built sensor mount

Reach Planning

- Generate additional approach vectors to compensate the geometry of the robot arm
- Generate a set of collision-free viapoints using the point cloud
- Avoid sensor mount using MoveIt’s obstacle avoidance



Future Work

- Comparison of grasping performance with ”standard” approach
  - Database of object models
  - Model fitting using ICP
- Robot learns good/bad grasps instead of manual labeling

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