Recognition and Pose Estimation of Rigid Transparent Objects with a Kinect Sensor

Ilya Lysenkov
Itseez
ilya.lysenkov@itseez.com

Victor Eruhimov
Itseez
victor.eruhimov@itseez.com

Gary Bradski
Willow Garage
gary@industrial-perception.com

Motivation

Mrs. Cupcake's blog, http://bit.ly/a-lot-of-glass

Robots should be able to clean out your table with glassware. It means they have to recognize and estimate poses of transparent objects to grasp them.
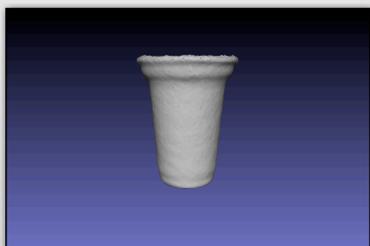
Challenges

- 3D sensors can't estimate depth or produce point clouds for transparent objects
- Transparent objects appearance heavily depends on background behind them
- Object 2D image is distorted due to refraction, reflection and specularities

K. McHenry, J. Ponce, D. Forsyth, Finding glass, CVPR 2005.
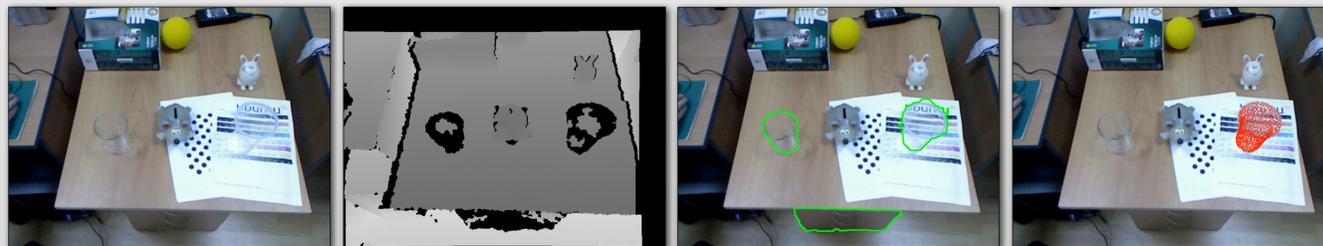
Proposed approach

Training stage

Create 3D models of objects with KinectFusion*

* Open source PCL implementation of the paper
R. Newcombe, S. Izadi, O. Hilliges, D. Molyneaux, D. Kim, A. Davison, P. Kohli, J. Shotton, S. Hodges, A. Fitzgibbon, KinectFusion: Real-time dense surface mapping and tracking, ISMAR 2011.

Testing stage

- **Segmentation**: Kinect can't estimate depth in regions where transparent objects are located ⟶ the invalid depth mask is used to segment them
- **Pose estimation**: edge fitting to segmented silhouettes
- **Recognition**: based on the fitting quality

Results

(a) Kinect RGB image (b) Kinect depth image
(c) Segmentation (d) Recognition and pose estimation
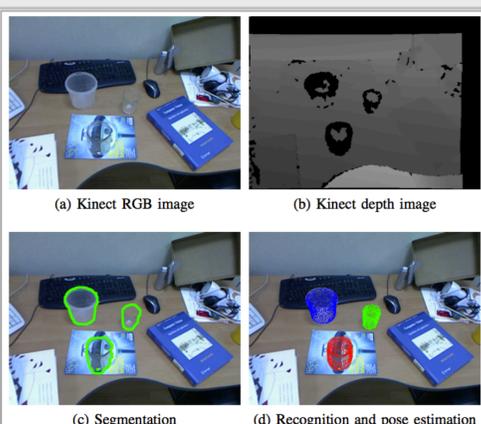
Example of the algorithm working

Object	Success rate	Mean translation error (cm)	
		absolute	relative
bank	0.99	0.3	0.2
bottle	0.99	1.2	0.5
bucket	1.00	0.5	0.5
glass	0.94	0.4	0.3
wine glass	0.97	1.1	0.5
mean	**0.98**	**0.7**	**0.4**

Accuracy of pose estimation

Grasping with the PR2 robot

	Uniform background	Cluttered background
Successful grasps	82.5%	80.0%

Grasping statistics for 8 objects