Amazon Picking Challenge

Yan-Song Chen

03.06.18
The Challenge
What is the hardest challenge?

Motion Planning

Grasp Planning

Mechanism Design

Perception
Survey from 2015 APC

- Perception: 4.52
- Grasping: 4.36
- Planning: 3.75
- Mechanism: 3.36
- Team: 2.54
- Dynamics: 2.48
Why pose estimation?
96%

Chose custom grasp solution
Amazon Picking Challenge 2016
Team MIT-Princeton
Video report
2D Segmentation

Project to 3D Point Clouds

Pose Estimation
2D Segmentation

Project to 3D Point Clouds

Pose Estimation
Semantic Segmentation
Fully Convolutional Network
Skip layers
Result of FCN
Training data
Pixels to Point Cloud
$f = \text{focal length}$

$c = \text{center of the camera}$
Point cloud projection
Outlier removal
Pose Estimation
Known correspondence

\[ X' = X - \mu_x \]
\[ Y' = Y - \mu_y \]
\[ W = XY^T = U\Sigma V^T \]
\[ R = UV^T \]
\[ t = \mu_x - R\mu_y \]
Iterative Closest Point (ICP)
Implementation Details

- Uniformize the point cloud

- Initialize by centroid and principal components

- Two pass ICP
Conclusion
PCA
(Pearson 1901)
PCA

1901

Convex Hull
(Graham 1972)
Outlier Detection (1990’s)

- PCA
- Convex Hull
PCA
1901

Outlier
1901
1990’s

Convex Hull

ICP (Besl & McKay 1992)
Conclusion

Nice integration of existing algorithms

Objects not generalizable
References

Online resources

[1] Coursera: ICP tutorial
[4] Pinhole camera model
[5] Amazon Robotics Website
[6] Shelf and Tote dataset

Publications

[2] Analysis and Observations From the First Amazon Picking Challenge