Adaptive Multi-layered Perception for Picking in Clutter with Parameter Reinforce Learning via Experience in Task

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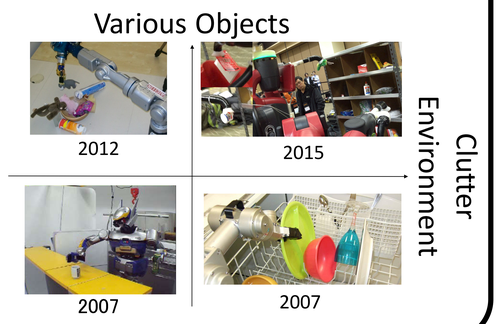
Abstract

It is still difficult for robot to complete tasks in clutter environment. We propose a learning approach for robot to be adaptive to the uncertainty of vision data from environment which the designer of the robotic system had not estimated. Our approach is a general way to estimate better parameter for the task with adaptiveness to the environment status.

1. Introduction

Robot needs to do picking task with more
- Various objects
- Clutter environments

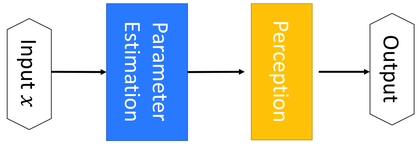
In this case, there are various object/obstacle state the system designer did not assume, and this requires adaptive perception system with self-supervision of robots.

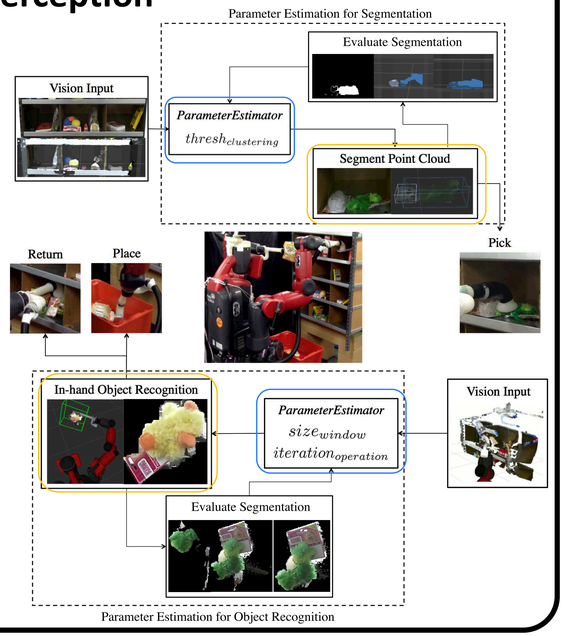


2. Picking System with Adaptive Perception

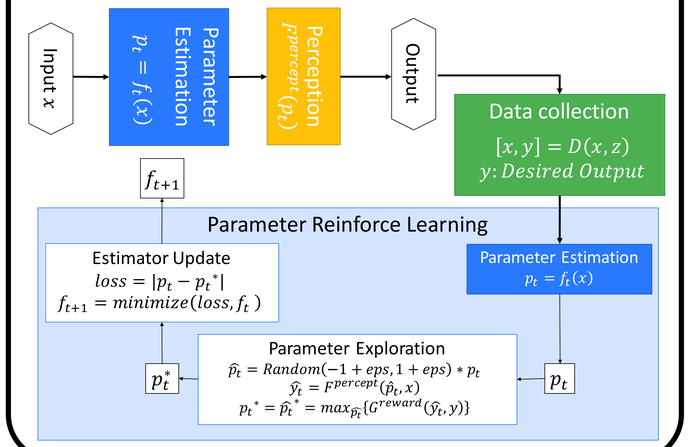
Picking system
1. Segment based on point cloud
2. Pick
3. In-hand object recognition
4. Place or Return

Adaptive Perception =
Parameter Estimation +
Multi-layered Perception





3. Parameter Reinforce Learning



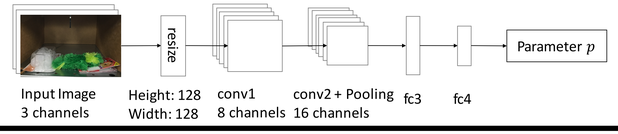
4. Data Collection

1. Object segmentation
   - Object can be segmented by picking.
   - Desired segmentation output is collectable by comparing before/after picking.
2. Target object verification
   - Recognition result while hand is stopping is reliable.
   - Desired recognition result is collectable by stopping the hand.

5. Parameter Estimation Network

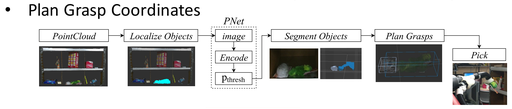
Network structure
- 2 Convolutional Network Layers + 2 Fully Connected Layers.

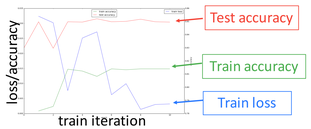
Pretraining with convolutional auto-encoder
- Convolutional auto-encoder with deconvolution + unpooling.
- Encoding layers is used for estimation.
- The encoded units are initialized as ones vector.



6. Experiment

1. Object segmentation
   - Localize object point cloud by location
   - Parameter estimation from depth (x) : $p^{thresh} = f(x)$
   - Euclidean clustering segmentation :
     $clusters = EuclidClustering(PointCloud, p^{thresh})$
   - Plan Grasp Coordinates

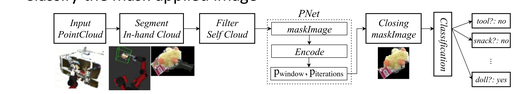


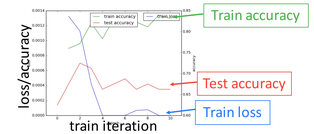


	Accuracy iter=0	Accuracy iter=10
train	78.5%	***81.5%***
test	82%	***85%***

Training result with 5 collected data

2. Target object verification
   - In-hand point cloud segmentation with self filtering
   - Parameter estimation from mask image (x) : $p^{thresh} = f(x)$
   - Closing mask image : $mask^{dst} = Closing(mask^{src}, p^{iteration}, p^{window})$
   - Classify the mask applied image





	Accuracy iter=0	Accuracy iter=10
train	76%	***83%***
test	62.5%	***66.3%***

Training result with 130 collected data

7. Conclusion

- We propose a learning-based method to introduce adaptive perception into robotic system.
- The parameter estimation network with data-collection system can be used for adaptive vision-based perception in general.
- We applied the proposed method to 2 perceptions in a picking system and got **3 - 4 %** accuracy rises.