CAREER: Visual Manipulation Learning for Challenging Object Grasping (2022-2027)

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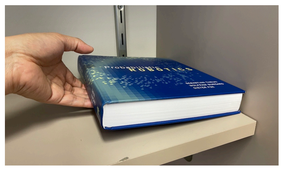
Overview

Goal: To develop *algorithms* that enable robots to grasp objects in *challenging* settings

Challenges in Object Grasping


clutter


constrained environment


severe occlusions

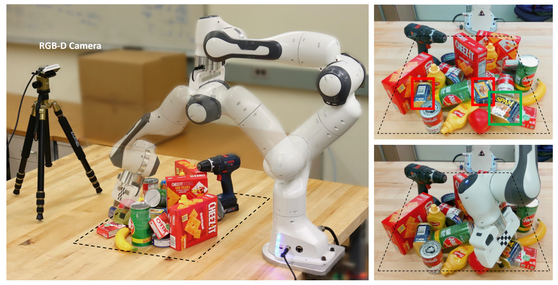
Thrusts
1. Context-Aware Object Grasping
2.Object Grasping via Leveraging Fixtures
3.Object Searching and Grasping

Intellectual Merit

Advances the state of knowledge regarding

1) How to effectively find successful grasps by considering **grasping-related contexts**, such as *clutteredness* and *potential collision*
2) How to learn to **harness** objects fixed to an environment to grasp objects
3) How to **search** for initially **hidden objects** using *robotics manipulation*, and how to **scale up** the number of objects robots can handle by using either *images* or natural *language*.

Context-Aware Object Grasping

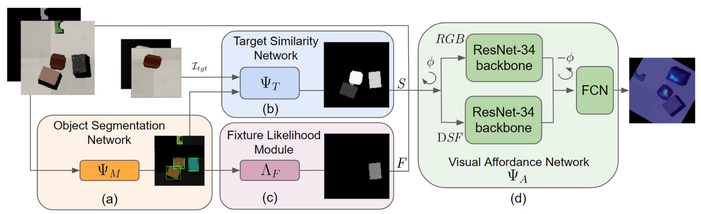


- 6-DoF grasp pose + reasoning object relations
- Grasp Graph Neural Network (G2N2)
- Shape completion-based grasp sampling

[Lou et al., ICRA'22]

Object Grasping via Leveraging Fixtures

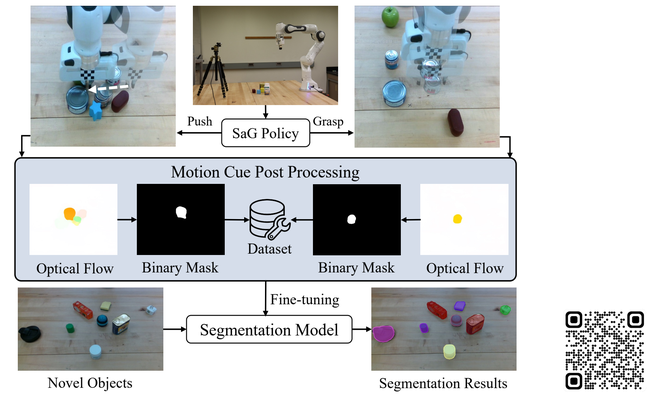

Slide-to-Wall grasping



[Sasagawa and Choi, IROS'22]

Object Searching and Grasping

Segment novel objects via robot-object interaction



[Yu and Choi, ECCV'22]

Broader Impact

Education

- New *Curriculum* Development for Robotics Program at UMN (EE5271: Robot Vision)
- Undergraduate *Mentoring* (EE4951W: Senior Design Project, Honors Thesis)

Society

- Increased **economic competitiveness** of the **US** by facilitating deploying robotic manipulators to *flexible manufacturing* and other application domains (*agriculture, warehouse, eldercare*)

References

- Lou et al., Learning Object Relations with Graph Neural Networks for Target-Driven Grasping in Dense Clutter, *ICRA 2022*
- Sasagawa and Choi, Fixture-Aware DDQN for Generalized Environment-Enabled Grasping, *IROS 2022*
- Yu and Choi, Self-supervised Interactive Object Segmentation Through a Singulation-and-Grasping Approach, *ECCV 2022*
- Yu et al., IOSG: Image-driven Object Searching and Grasping, *IROS 2023* (submitted)

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