Karlsruhe Institute of Technology

Autonome Lernende Roboter (ALR)

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Project Type

- ☑ Master Thesis
- ☐ Bachelor Thesis
- ☐ Research Project

Supervisors

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Difficulty

Algorithmic

Math

Application

Context-Aware Active Grasping on Unseen Objects

Description

Grasping is one of the fundamental and crucial subtasks of robotic manipulation. However, reliable robotic grasping is challenging due to imprecise sensing and actuation. Recently, many works [2, 3] have shown advances in predicting grasp success directly from depth images by training a Deep Convolutional Neural Network (CNN) with a large-scale synthetic dataset. However, these methods focus more on local geometric features of the object due to a single view or partial observation. Also, objects with similar shapes could include different properties, e.g., material, texture, mass distribution and friction coefficient. Therefore, without contexts and using depth, the model cannot capture these global features. Thus, this might lead to a failure in many real-world applications.

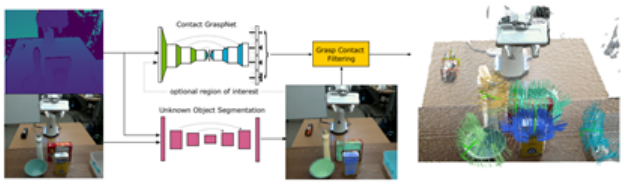

Figure 1: Contact-GraspNet [3].

In this thesis, we propose to leverage global features from contexts in an active-learning manner using CNPs[1]. The features of an object (e.g., inhomogeneous density, friction coefficient, material or texture of different parts) should be captured implicitly from the collected prior trials. The model is expected to form the likelihood of underlying physical parameters and choose the best grasping point in the next try. Furthermore, we will transfer and test the performance in the real world with collecting trials in an online fashion, though the model is trained fully with simulation. This work could potentially complement our current project, for instance, picking objects with plastic packages or inhomogeneous properties.

Tasks

The tasks in this project will involve:

- Simulation. Improve the existing simulation framework with Mujoco, align with the real robot setup.
- Dataset. Generate synthetic dataset for training and evaluation.
- Algorithmic Extension. Extend baselines[2, 3] with contextual encoder using CNPs.
- Transferability. Benchmark grasping performance in the real world with more challenging objects using Franka robot.

References

[1] Marta Garnelo, Dan Rosenbaum, Christopher Maddison, Tiago Ramalho, David Saxton, Murray Shanahan, Yee Whye Teh, Danilo Rezende, and S. M. Ali Eslami. Conditional neural processes. In Jennifer Dy and Andreas Krause, editors, *Proceedings of the 35th International Conference on Machine Learning*, volume 80 of *Proceedings of Machine Learning Research*, pages 1704–1713. PMLR, 10–15 Jul 2018.

[2] Jeffrey Mahler, Jacky Liang, Sherdil Niyaz, Michael Laskey, Richard Doan, Xinyu Liu, Juan Aparicio, and Ken Goldberg. Dex-net 2.0: Deep learning to plan robust grasps with synthetic point clouds and analytic grasp metrics. 07 2017.

[3] Martin Sundermeyer, Arsalan Mousavian, Rudolph Triebel, and Dieter Fox. Contact-graspnet: Efficient 6-dof grasp generation in cluttered scenes. 2021.