KIT
Karlsruher Institut für Technologie

BOSCH
Invented for life
Bosch Center for Artificial Intelligence

Autonome Lernende Roboter (ALR)
Prof. Gerhard Neumann

Project Type

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

Supervisors

- ☞ Ngo Anh Vien
- @ anhvien.ngo@bosch.com

Difficulty

Algorithmic

Math

Application

End-to-End Differentiable Grasping Network

Description

Robotic bin-picking is an important task in robotic manipulation. Most existing learning approaches base their training on simulation environment that poorly captures real physics. In addition, such simulation environments are not inherently differentiable, thus automatic differentiation tools can not exploit physical property gradients in order to improve grasping efficiency. In this project, the student is expected to explore possibilities to use existing differentiable physics engines to build an end-to-end grasping network for bin-picking tasks.

We will base our work on a recent paper [3] (see the figure below). They show the computation of grasp poses for high-DOF grippers in an unsupervised manner can be made very efficiently by differentiating through the grasp quality.
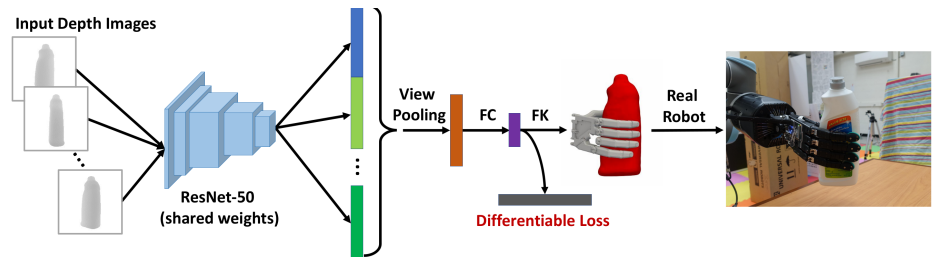
Tasks

The tasks in this project will involve:

- Literature Review: Getting familiar background of differentiable physics engines and automatic differentiation, e.g. [1, 2].
- Implementation: Re-implement a recent state-of-the-art deep differentiable grasping network.
- Evaluation: Evaluating the implemented algorithm on the publicly available dataset provided by the paper [3].
- Modification: Modifying the implemented algorithm for a different gripper, i.e. a parallel gripper of a Franka Panda robot.
- Improvement: Exploring possibilities for improvement, e.g. changing the network architecture and algorithm to capture more complex tasks or integrating another differentiable physics engine [2].

Qualifications

- Studies in the field of Computer Science, Cybernetics, Mechanical Engineering, Mechatronics, Mathematics, or comparable.
- Experience in Python (knowing PyTorch is a plus)
- Strong background in AI, machine learning, or mathematics
- Motivation for learning and experimenting on physical systems.

References

[1] Akshay Agrawal, Brandon Amos, Shane T. Barratt, Stephen P. Boyd, Steven Diamond, and J. Zico Kolter. Differentiable convex optimization layers. In Hanna M. Wallach, Hugo Larochelle, Alina Beygelzimer, Florence d'Alché-Buc, Emily B. Fox, and Roman Garnett, editors, *Advances in Neural Information Processing Systems 32: Annual Conference on Neural Information Processing Systems 2019, NeurIPS 2019, December 8-14, 2019, Vancouver, BC, Canada*, pages 9558–9570, 2019.

[2] Filipe de Avila Belbute-Peres, Kevin Smith, Kelsey Allen, Josh Tenenbaum, and J Zico Kolter. End-to-end differentiable physics for learning and control. *Advances in neural information processing systems*, 31:7178–7189, 2018.

[3] Min Liu, Zherong Pan, Kai Xu, Kanishka Ganguly, and Dinesh Manocha. Deep differentiable grasp planner for high-dof grippers. *Robotics: Science and Systems (RSS)*, 2020.