TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

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B A C H E L O R T H E S I S
for
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Exploiting model-based reinforcement learning for non-prehensile manipulation of deformable objects

Problem description:

Non-prehensile manipulation actions, like pushing or folding, aim at modifying the pose of an object without firmly grasping it. Non-prehensile manipulation is a hard task and, especially when the object to manipulate is deformable, it is far from being fully solved [1]. This is because the task at hand is hard to model and the complex model makes the defign of a control policy non trivial. Reinforcement learning (RL), or leaning by self-practice, is an appealing approach widely used in robotics to learn complex skills. In particular, model-based RL approaches [2, 3], combined with non-linear optimal control approaches like the Iterative Linear Quadratic Gaussian (ILQG) [4], seem well-suited to execute non-prehensile manipulation tasks.
In this Master thesis work, the student has to implement a learning based approach for non-prehensile manipulation of deformable objects. The approach starts with a simplified task model, e.g. considering a rigid body, and improves both the task model and the control policy with data from real executions. The effectiveness of the developed approach is demonstrated with experiments on a real robot.

Tasks:

- Literature research on model-based reinforcement learning and non-prehensile manipulation
- Combination of PI-REM [2] and ILQG [4]
- Application of model-based RL to non-prehensile manipulation of a deformable object
- Evaluation on a real robot

Bibliography:

[1] F. Ruggiero, V. Lippiello, and B. Siciliano, "Nonprehensile Dynamic Manipulation: A Survey", in *Robotics and Automation Letters*, 2018.
[2] M. Saveriano, Y. Yin, P. Falco, and D. Lee, "Data-Efficient Control Policy Search using Residual Dynamics Learning", in *International Conference on Intelligent Robots and Systems*, 2017.
[3] S. Levine and P. Abbeel, "Learning Neural Network Policies with Guided Policy Search under Unknown Dynamics", in *Neural Information Processing Systems*, 2014.
[4] Y. Tassa, N. Mansard, and E. Torodov, "Control-limited differential dynamic programming", in *International Conference on Robotics and Automation*, 2014.

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