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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Kinaesthetic Teaching of Manipulation Tasks using Physically Realistic Simulations

Problem description:

In order to allow complex robotic platforms to execute human-like tasks in real environments, it is necessary to provide robots with trajectory planning mechanisms that permits executing sequences of actions to fulfil given tasks. One of the most broadly used mechanisms for trajectory planning is dynamic movement primitives (DMPs) [3], whose parameters are usually learned from demonstrated trajectories (training instances) generated by kinaesthetic guidance of real robot manipulators [2]. However, generating these example trajectories using real robot platforms has two important drawbacks. On the one hand, setting up a real robot might be a tedious task that demands a significant amount of effort and time. On the other hand, real robots have always an inherent risk of damage due to misuse or to the inevitable wear and tear. This project addresses these limitations by implementing a physically realistic simulation of a robotic arm that is used for kinaesthetic teaching. Using a robot simulator allows collecting training instances faster and with no risk of damage compared to using a real platform. The project comprises the implementation of a simulated replica of real robotic arm where manipulation actions (e.g. pick, place, takeout, pour, etc.) are demonstrated. The learned DMPs are associated to symbolic descriptions of the demonstrated actions compatible with task planning approaches [1] that are used to generate plans for the execution of manipulation tasks. The validity of the approach is assessed by comparing the performance in the simulated and real platform in the execution of these plans.

Tasks:

- Literature review.
- Implementation of the simulated platform using the robot simulator V-Rep.
- Implementation of DMPs generation from demonstrated trajectories.
- Association of DMPs parameters to planning operators.
- Performance assessment.

Bibliography:

[1] Alejandro Agostini, Carme Torras, and Florentin Woergoetter. Efficient interactive decision-making framework for robotic applications. *Artificial Intelligence*, 247:187–212, 2017.

[2] Riccardo Caccavale, Matteo Saveriano, Alberto Finzi, and Dongheui Lee. Kinesthetic teaching and attentional supervision of structured tasks in human–robot interaction. *Autonomous Robots*, pages 1–17, 2018.

[3] Stefan Schaal. Dynamic movement primitives-a framework for motor control in humans and humanoid robotics. In *Adaptive motion of animals and machines*, pages 261–280. Springer, 2006.

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