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M A S T E R ' S T H E S I S
for
Florian Winter
Student ID , Degree

Reinforcement Learning of Robot's Impedance Behaviors

Problem description:

Robotics applications that involve contacts with the environment require specific force profiles. Controlling only the position, in fact, it is not sufficient to accomplish the task when the robot exchanges forces with the environment. Approaches has been proposed to learn suitable impedance gains from the variability in the task's demonstrations and to generate a desired force profile [1], [2]. Nevertheless, it is desirable, in real environments, to adapt the impedance gains and the resulting force behavior to new dynamic scenarios.

In this Master Thesis work the student has to implement a Reinforcement Learning (RL) based algorithm to refine the learned force profile while the robot is executing a task [3]. To execute the learned force behavior, a customized impedance control [4] will be adopted. According to the task specification, the learned force behavior will be then executed as a first or lower priority task.

Tasks:

- Literature overview on Impedance Control and Reinforcement Learning
- Learning the Cartesian impedance (Learning from Demonstrations)
- Learned force refinement according to external stimuli using RL
- Experimental evaluation on a KUKA LWR4+

Bibliography:

[1] K. Kronander and A. Billard. Online Learning of Varying Stiffness Through Physical Human-Robot Interaction. in *International Conference on Robotic and Automation (ICRA)*, 2012.
[2] L. Rozo, S. Calinon, D.G. Caldwell, P. Jimenez, and C. Torras. Learning collaborative impedance-based robot behaviors. in *AAAI Conference on Artificial Intelligence*, 2013.
[3] P. Kormushev, S. Calinon and D.G. Caldwell. Robot Motor Skill Coordination with EM-based Reinforcement Learning. in *Proceedings of the IEEE/RSJ Intl Conf. on Intelligent Robots and Systems (IROS)*, 2010.
[4] H. Sadeghian, L. Villani, M. Keshmiri and B. Siciliano Task-Space Control of Robot Manipulators With Null-Space Compliance. in *Transactions On Robotics.* vol. 30, no. 2, pp. 493-506, 2014.

Supervisor:	M. Sc. Matteo Saveriano
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Intermediate Report:	
Delivery:	

(D. Lee)
Carl-von-Linde Fellow