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M A S T E R ' S T H E S I S
for
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Learning Haptic Feedback Controller Gains from Human Demonstrations

Problem description:

Robustly grasping an object in the presence of uncertainty is still a wide-open problem in the robotics community. Traditional control approaches rely on the precise knowledge of the system state that ought to be controlled. Commonly a state estimator is developed that relies on some sensory input and provides the required state estimate. Recently, we have demontrated how a controller can directly operate on sensory traces as input. We have shown how this is robust towards uncertainty in sensing and actuation [2]. We have also seen approaches that learn the mapping directly from pixels to torques [1]. These however require either a good initial policy or significant amounts of training data. We want to explore how a controller and its feedback gains can be learned from large amounts of data. Specifically, we are considering the task of dexterous manipulation of an object. For data collection, we want to utilize teleoperation of a hand in a virtual environment with simulated rigid-body physics as for example provided by the open-source robot simulator Gazebo . The input of the controller can be a variety of sensory traces that may consist of haptic, visual or any combination of those features. The output may be computed for each joint of the hand or for some reduced number of degrees of freedoms, i.e. for some grasp synergies.

Tasks:

- Literature study on Learning Control and Grasp Synergies
- Development of the data collection setup using the CyberGlove II and a VICON mocap system.
- Exploration of different learning methodologies
- Testing generalisation capabilities of the developed method

Bibliography:

[1] Sergey Levine, Chelsea Finn, Trevor Darrell, and Pieter Abbeel. End-to-end training of deep visuomotor policies. *arXiv preprint arXiv:1504.00702*, 2015.

[2] Peter Pastor, Ludovic Righetti, Mrinal Kalakrishnan, and Stefan Schaal. Online movement adaptation based on previous sensor experiences. In *Intelligent Robots and Systems (IROS), 2011 IEEE/RSJ International Conference on*, pages 365–371. IEEE, 2011.

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