Learning Models for Underactuated Robotic Hands

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Abstract

Robotic hands commonly used in real-world applications are generally fully actuated, rigid and with several fingers. They have not proven practical, however, in real-world tasks partly due to their high cost and significant effort to calibrate, maintain, and repair them. There are also fundamental challenges in establishing stable grasps and controlling contact in the presence of uncertainty, especially for highly articulated hands that require complex sensing and redundant control schemes after contact. Underactuated compliant hands, on the other hand, are appealing due to their ability to adapt to an objects shape and maintain a stable grasp with open-loop control. While underactuated hands bring great promise, they also have certain limitations, primarily in the difficulty in modeling passively elastic joints. These issues are hindering the adoption of adaptive hands.

In my talk, I will address a low-cost solution in which highly capable robotic grippers are fabricated through 3D printing with minimal engineering effort. I will focus on important aspects required for efficient and accurate motion: feasible modeling of a hand and the algorithmic foundation to plan and control its motion. Modeling of a hand is performed by learning a stochastic state transition model while identifying the dominant features that are sufficient to express its motion and considering the lower-dimensional manifold in which the data lies on. Learning stochastic data-driven models provides not only a way to propagate forward the system dynamics, but also express the uncertainty present in the collected data. Therefore, such models enable planning in the space of state distributions, i.e., in the belief space. Hence, a robust motion planning algorithm is applied to find the path with the highest probability of reaching the goal.

Bio: Avishai Sintov received his B.Sc., M.Sc. and Ph.D. degrees in Mechanical Engineering from Ben-Gurion University of the Negev, in 2008, 2012 and 2016, respectively. He is currently a Senior Lecturer and the head of the Robotics Lab in the School of Mechanical Engineering at Tel-Aviv University. From 2016 to 2018, he was a post-doctoral research fellow at the Coordinated Science Laboratory, University of Illinois at Urbana-Champaign. Between 2018 to 2019, he was a post-doctoral research associate at the Department of Computer Science, Rutgers University. His research interests include manipulation planning, grasping and regrasping synthesis, human-robot interaction, machine learning and robot design.