Design and Fabrication of Robot Hands for Dexterous Tasks


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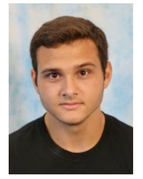
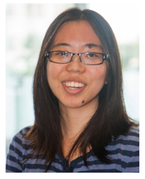

Jonathan King


Yuzi Nakamura

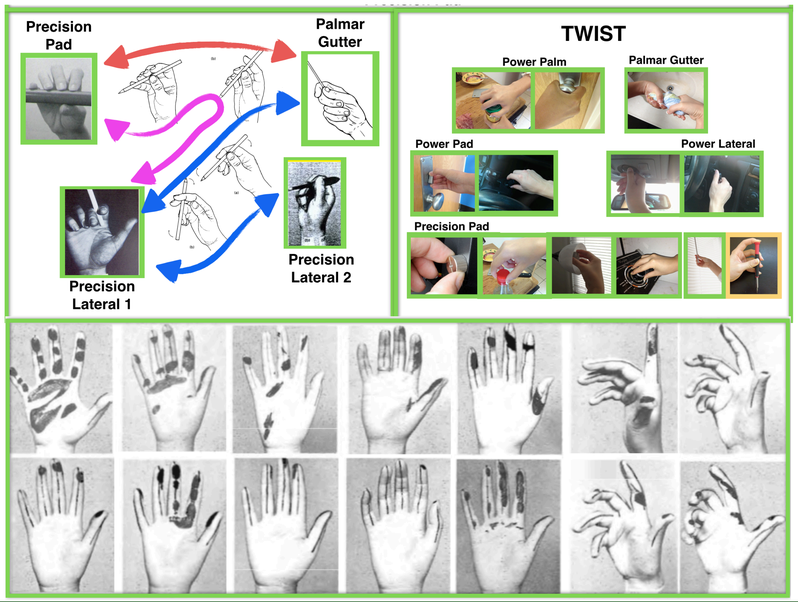
Problem and Goal

Robust dexterous manipulation is extraordinarily difficult for state of the art hands, but it is essential.

Our goal is to design robot hands from the ground up to do dexterous manipulation, including acquiring objects and moving between grasps.

Guiding Philosophy

- Begin with a task set that includes dexterous manipulation.
- Optimize mechanism and control together.
- Build intelligence into the mechanism (grasps are minima).
- Use compliant elements to apply common forces passively.
- Use joint stops etc. to transfer forces elsewhere.
- Design geometry and surface with manipulation in mind.
- Remember dexterous manipulation is a whole-hand activity.



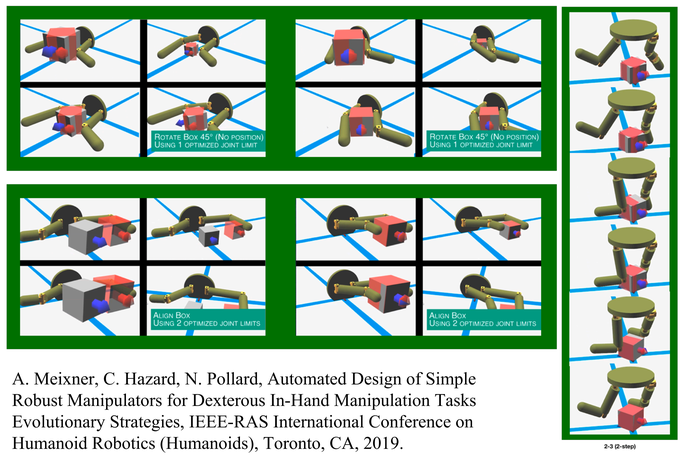
Highlights in Optimization

Optimized morphology, dynamic trajectory simultaneously
Customize for task set

C. Hazard, N. Pollard, and S. Coros, 2020. Automated Design of Robotic Hands for In-Hand Manipulation Tasks, International Journal of Humanoid Robotics (Online Ready).

Improved robustness of the mechanism

- Evolve morphology + controller simultaneously for task set
- Evaluate on multiple samples from uncertainty distribution
- Optimize for joint limits as well as traditional mechanism features

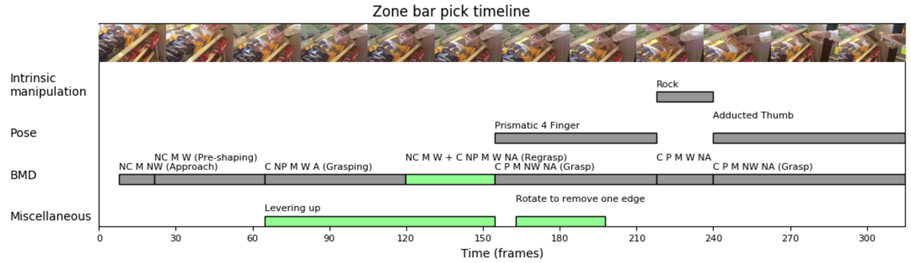


A. Meixner, C. Hazard, N. Pollard, Automated Design of Simple Robust Manipulators for Dexterous In-Hand Manipulation Tasks Evolutionary Strategies, IEEE-RAS International Conference on Humanoid Robotics (Humanoids), Toronto, CA, 2019.

Highlights in Annotation

Annotated human pick-and-place interactions “in the wild”

- 91 interactions with 60 objects
- three existing taxonomies and a miscellaneous category



Y. Nakamura, D. Troniak, A. Rodriguez, M. T. Mason, and N. S. Pollard, The Complexities of Grasping in the Wild, *IEEE RAS International Conference on Humanoid Robots (HUMANOIDS)*, Birmingham, UK, 2017.

Highlights in Soft Hands

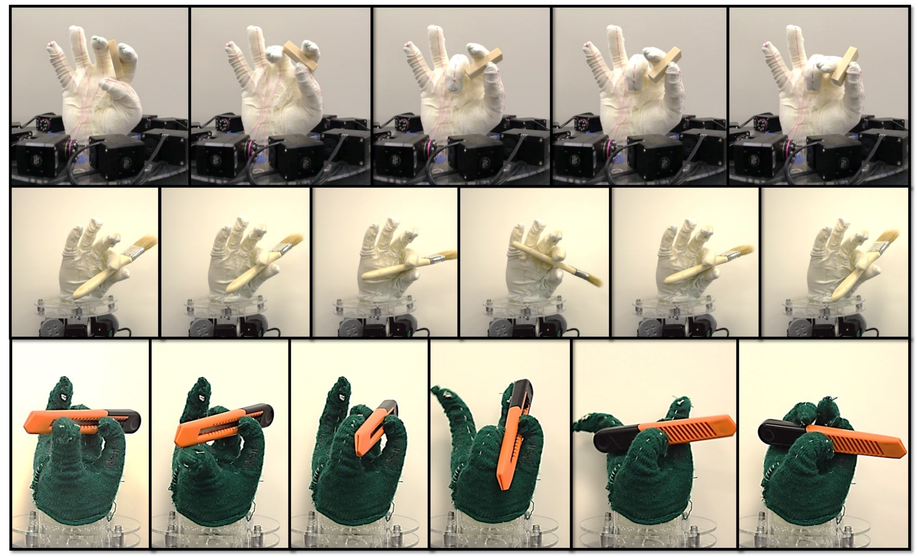
Fully soft hand design

- Custom geometry
- Custom tendon routings
- Low-cost
- Safe
- Dexterous

Finite element design interface

Model based IK control

New efforts in adding sensors



D. Bauer, C. Bauer, J. P. King, D. Moro, K.-H. Chang, S. Coros, and N. Pollard, 2020. Design and Control of Foam Hands for Dexterous Manipulation, International Journal of Humanoid Robotics (To Appear / Online Ready).