

Co-Design for Soft Manipulation at RBO: Past, Present, and Future

Alexander Koenig
Robotics and Biology Laboratory



What happened so far?

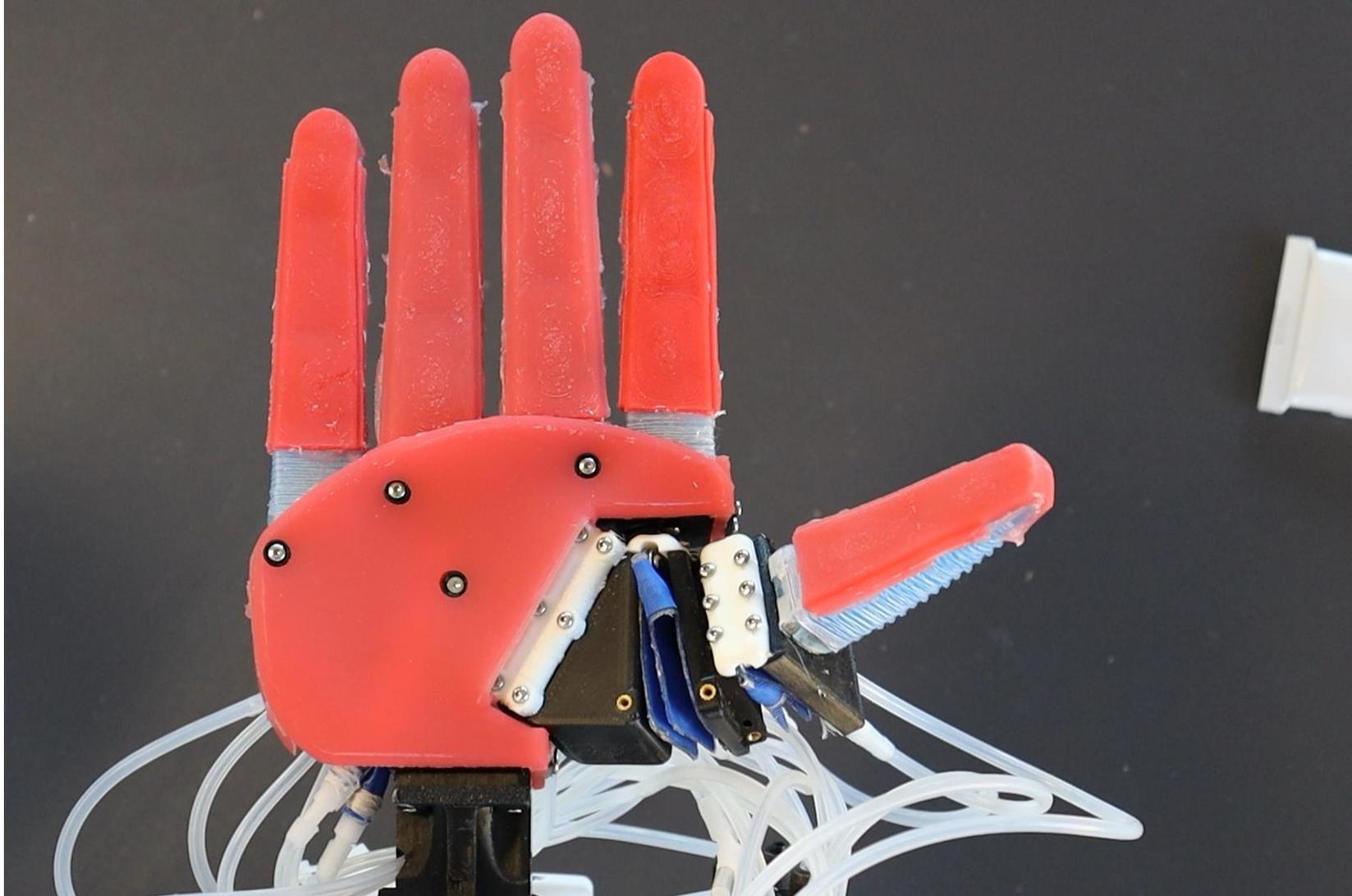


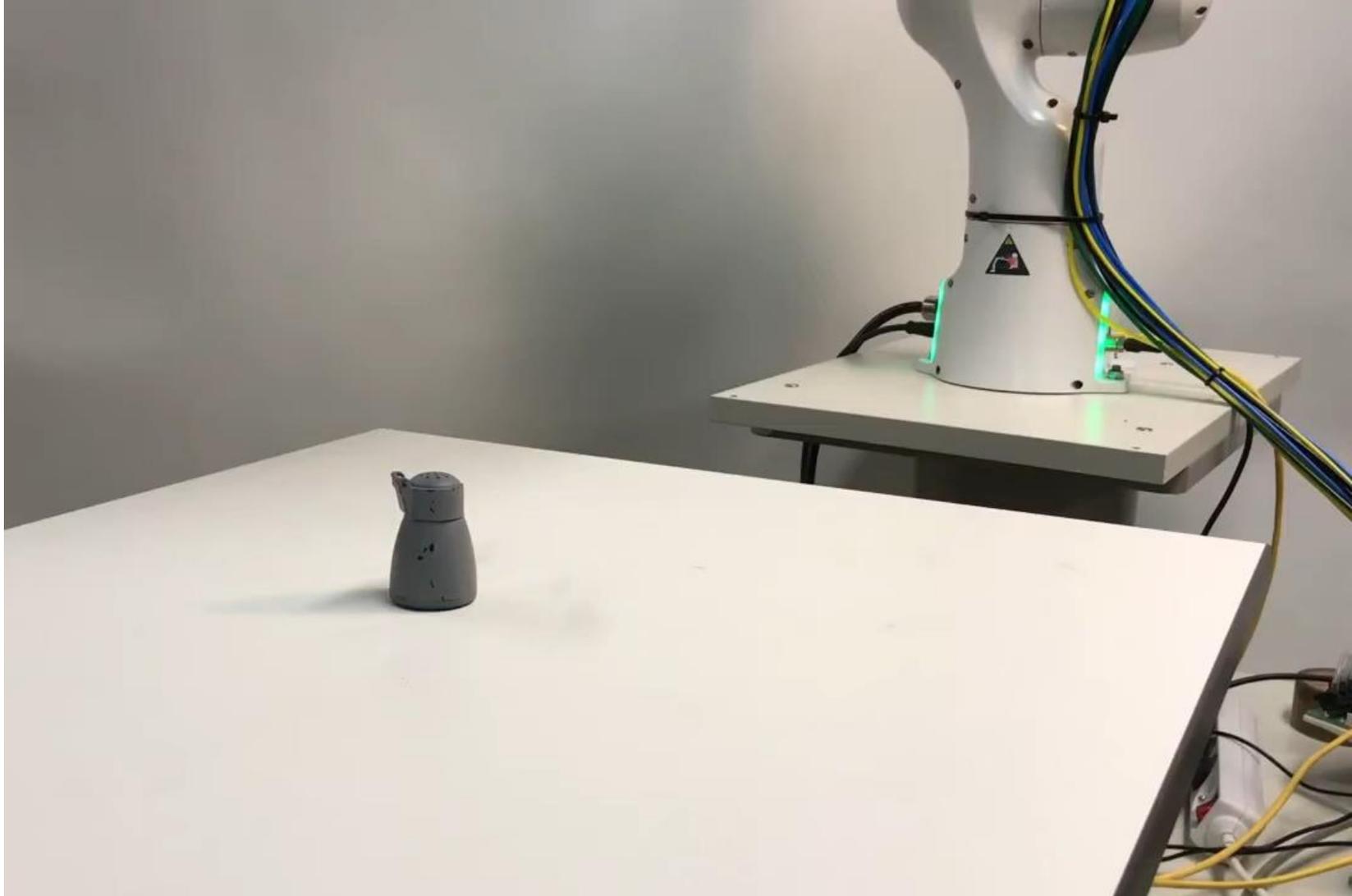
Morphology

Control



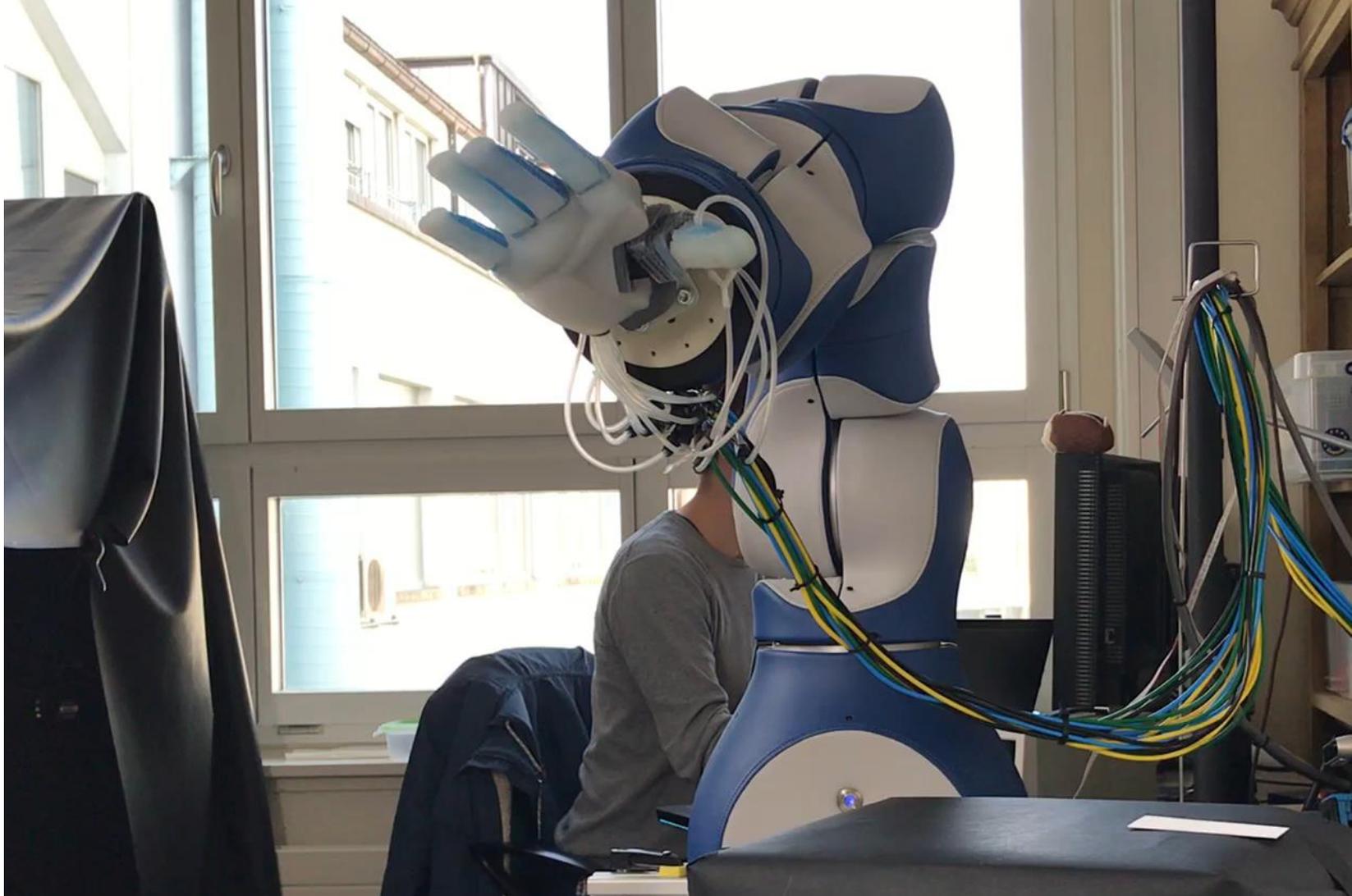
**Puhlmann,
Harris, Brock.**
“RBO Hand 3: A
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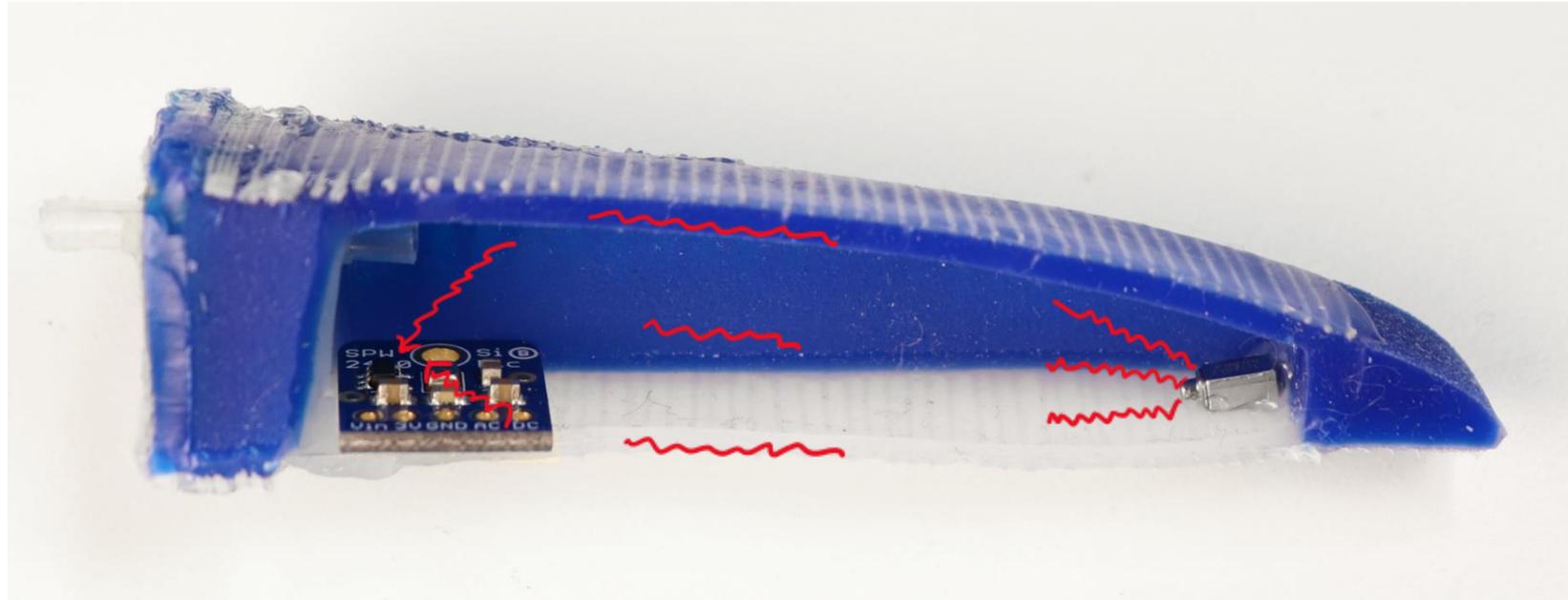
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(Acoustic) Morphological Sensing



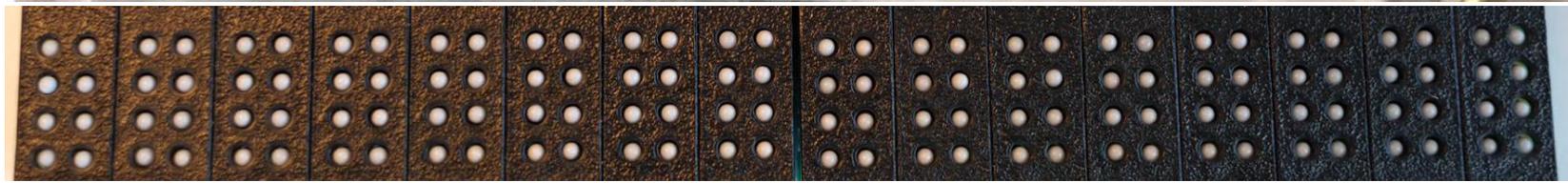
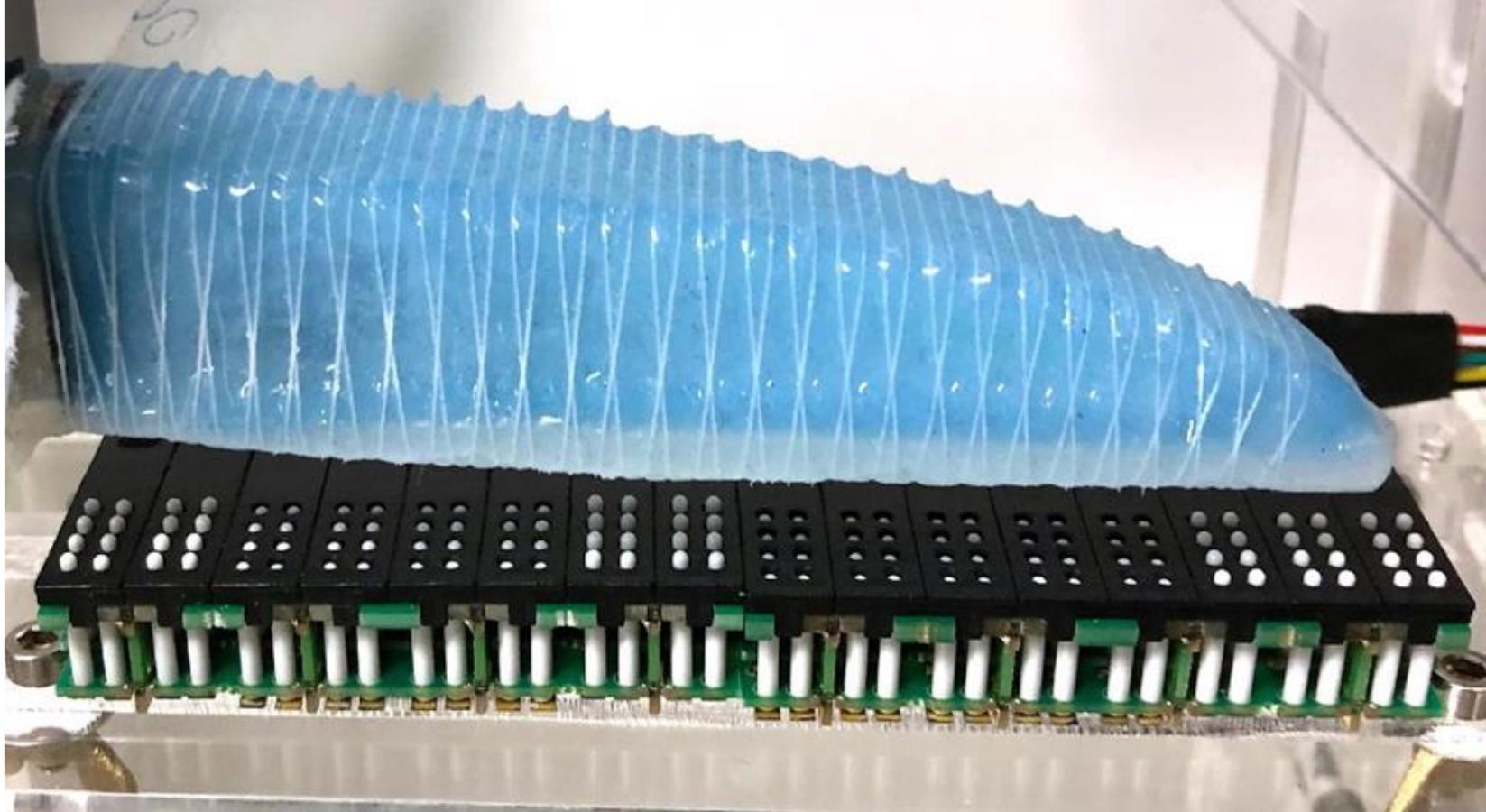
Wall, Zöller,
Brock. "Passive
and Active
Acoustic Sensing
for Soft
Pneumatic
Actuators" in
IJRR 2023



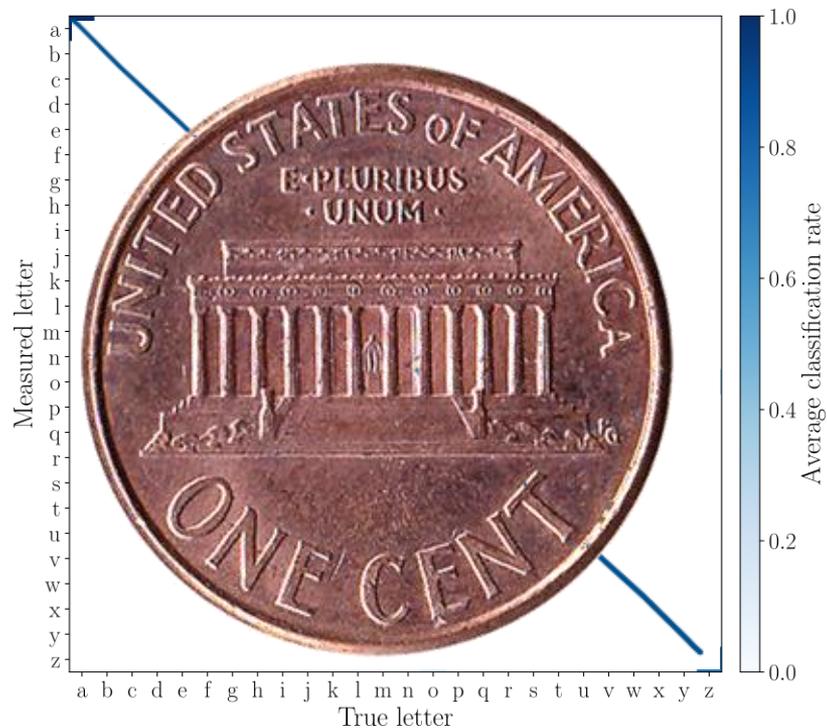
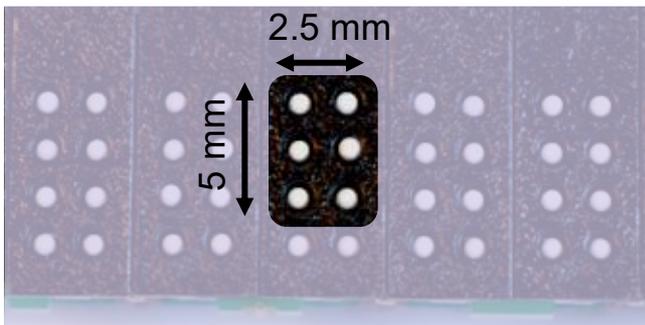
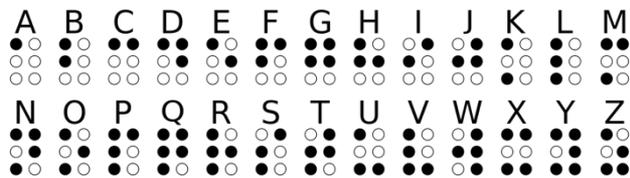
www.wildfilmsindia.com

Wall, Brock. "A
Virtual 2D Tactile
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2022





Wall, Brock. “A Virtual 2D Tactile Array for Soft Actuators Using Acoustic Sensing” in IROS 2022

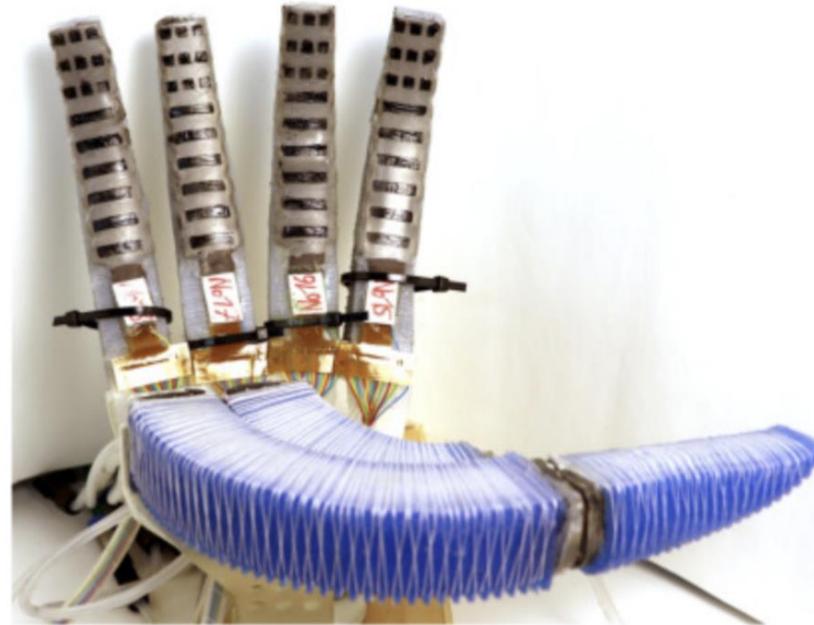


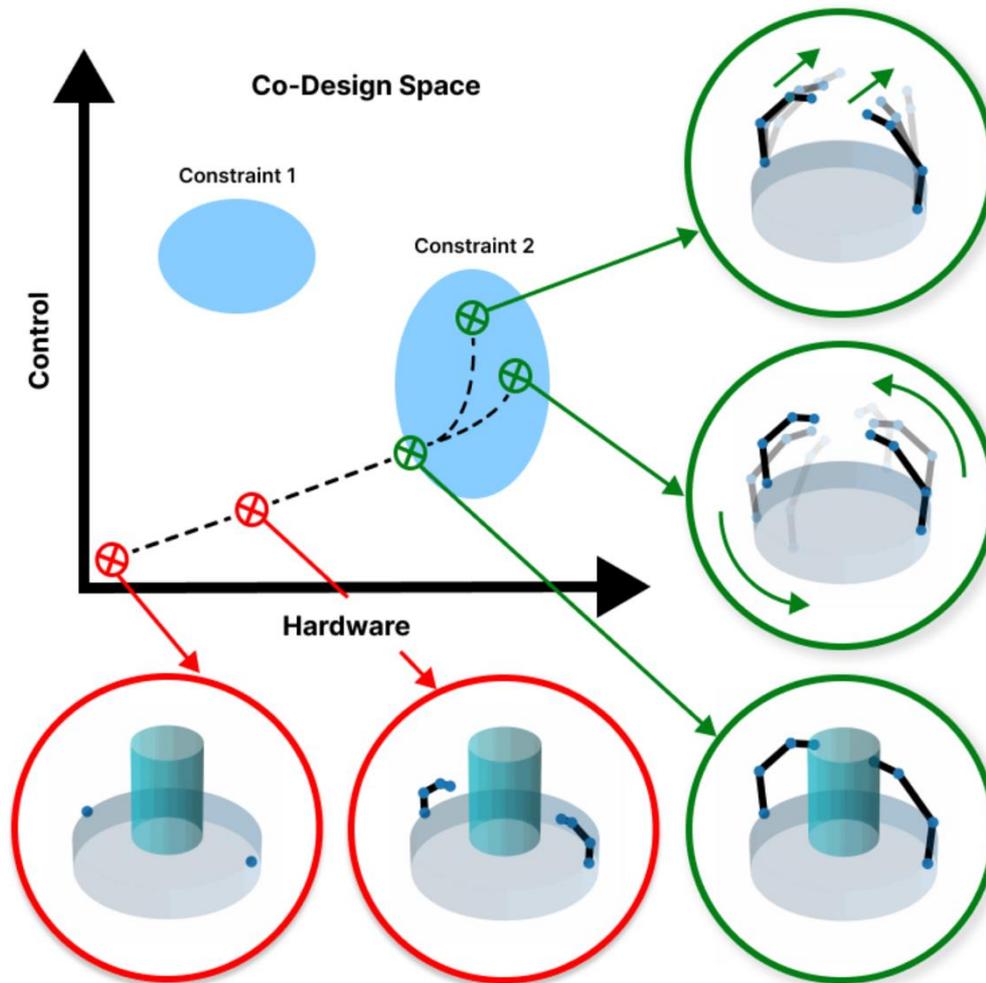
Wall, Brock. "A Virtual 2D Tactile Array for Soft Actuators Using Acoustic Sensing" in IROS 2022

**Wall, Zöller,
Brock.** “A
Method for
Sensorizing Soft
Actuators and Its
Application to the
RBO Hand 2” in
ICRA 2017

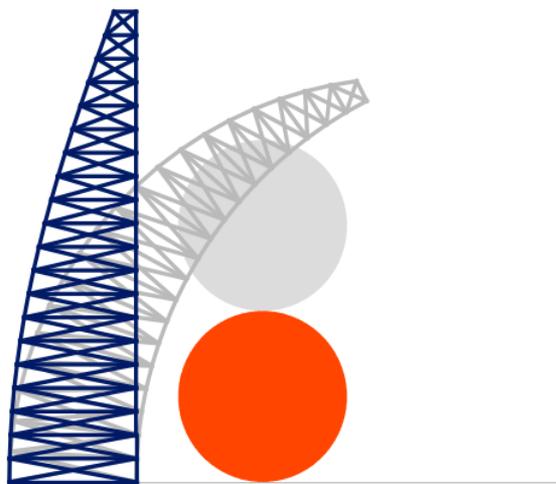


**Pannen,
Puhmann,
Brock.** “A Low-
Cost, Easy-to-
Manufacture,
Flexible, Multi-
Tixel Tactile
Sensor and its
Application to In-
Hand Object
Recognition” in
ICRA 2022.



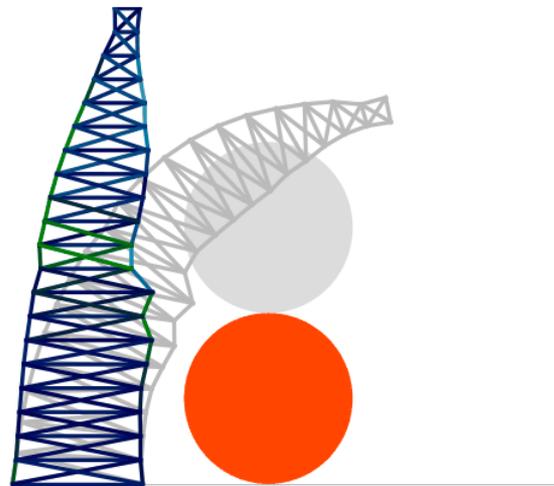


Vaish, Brock.
 “Co-Designing
 Manipulation
 Systems Using
 Task-Relevant
 Constraints” in
 ICRA 2024



Object Target

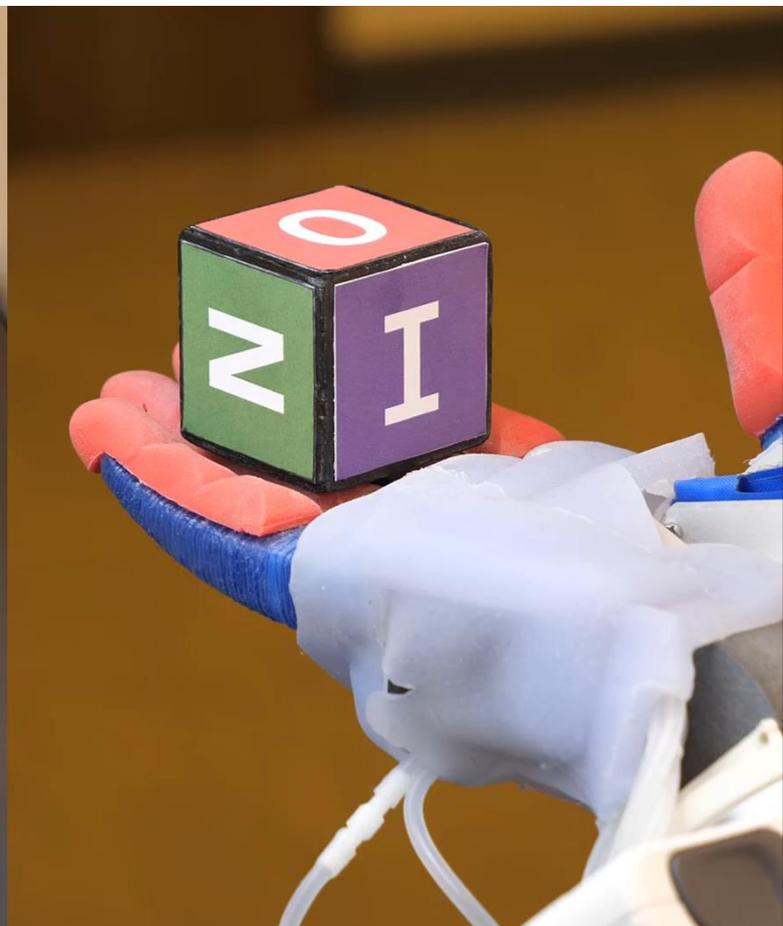
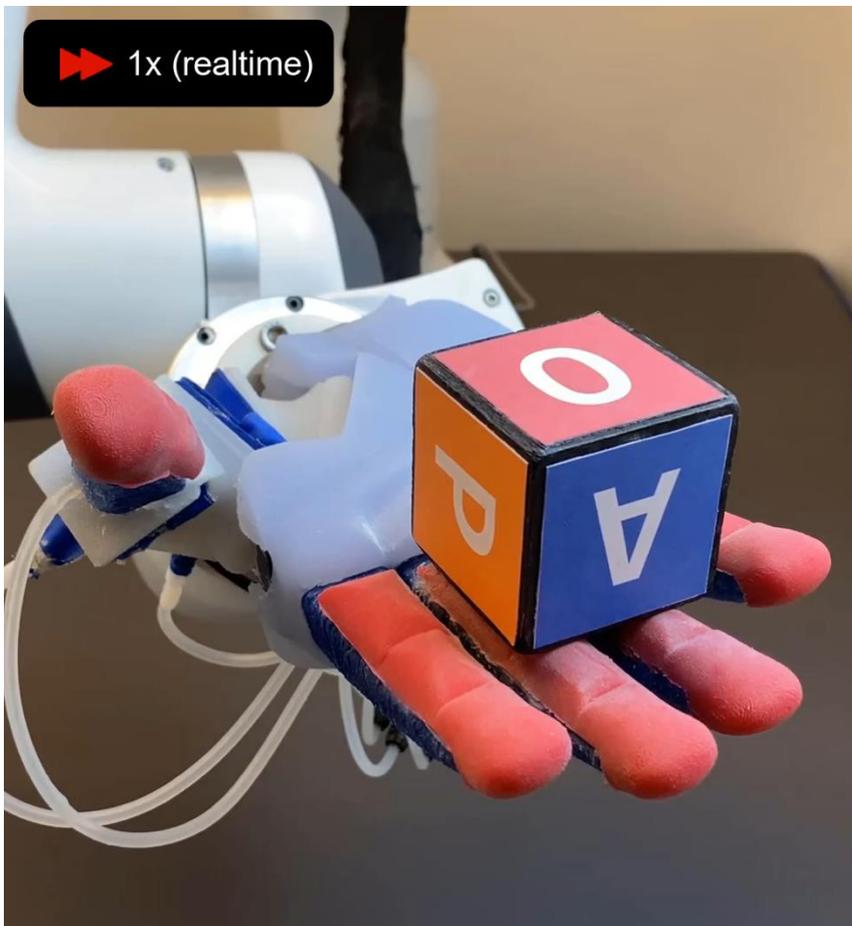
Iteration 0



Object Target

Iteration 100

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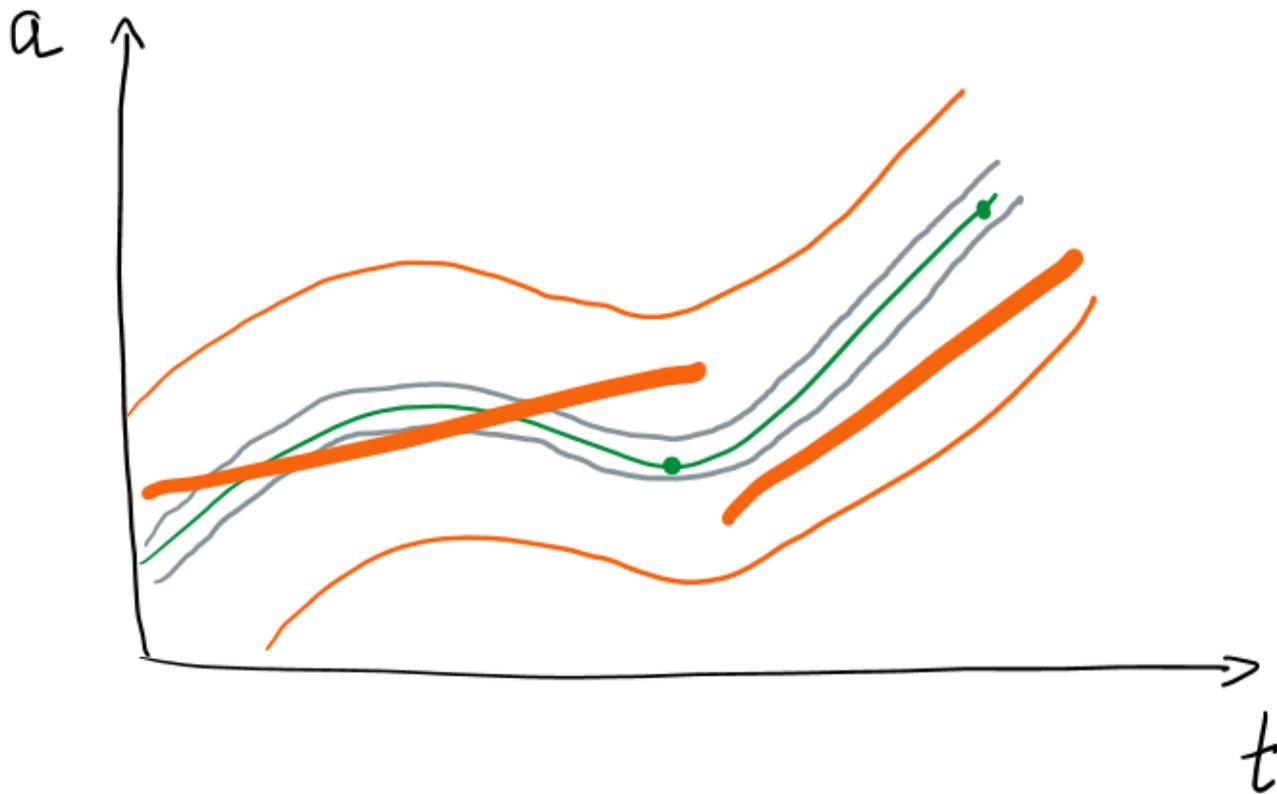


**Bhatt, Sieler,
Puhlmann,
Brock.**
“Surprisingly
Robust In-Hand
Manipulation: An
Empirical Study”
in RSS 2021

Learning a Manipulation Skill within Seconds

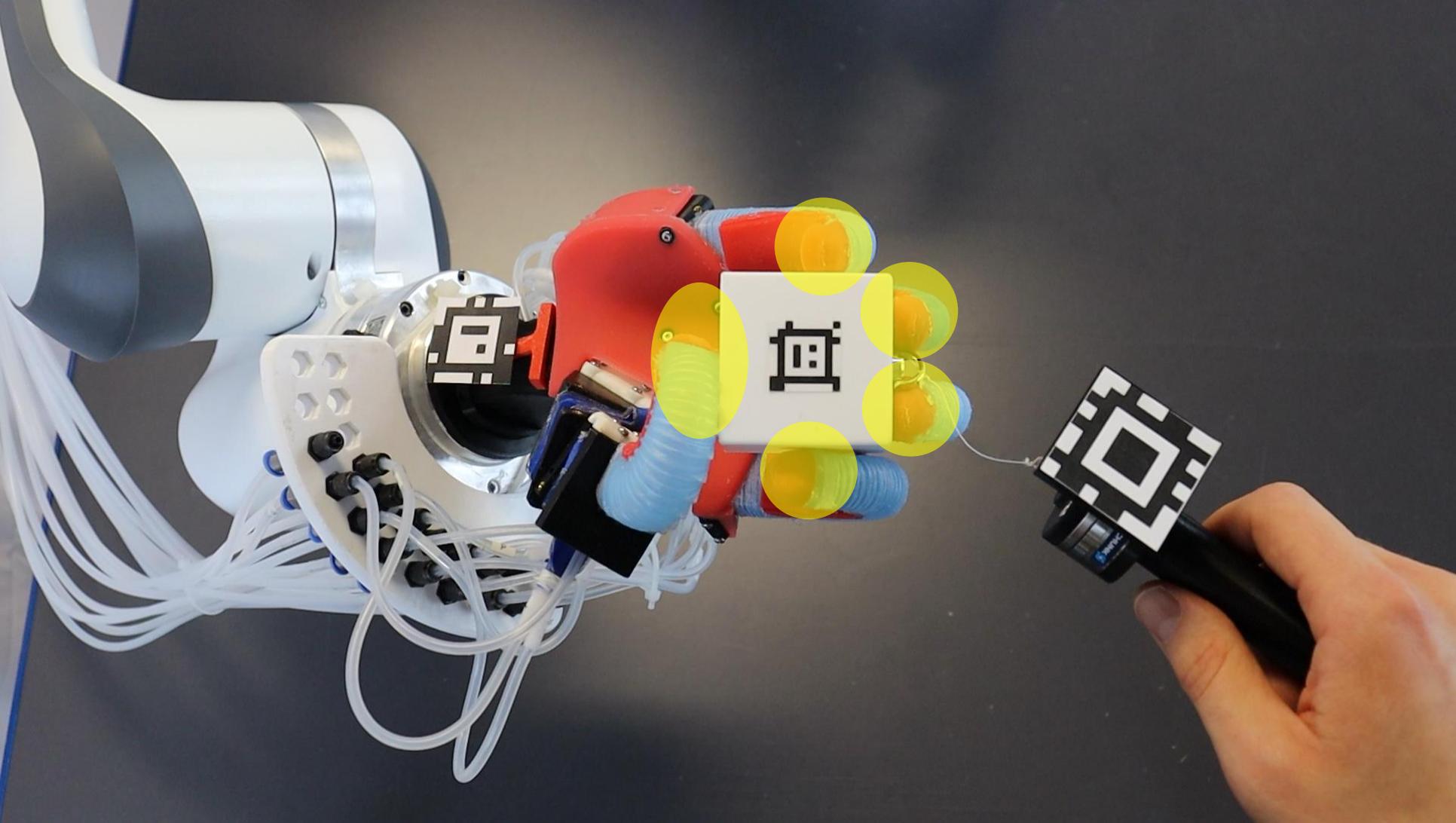
Leveraging Demonstration, Compliance,
Exploration and Feedback

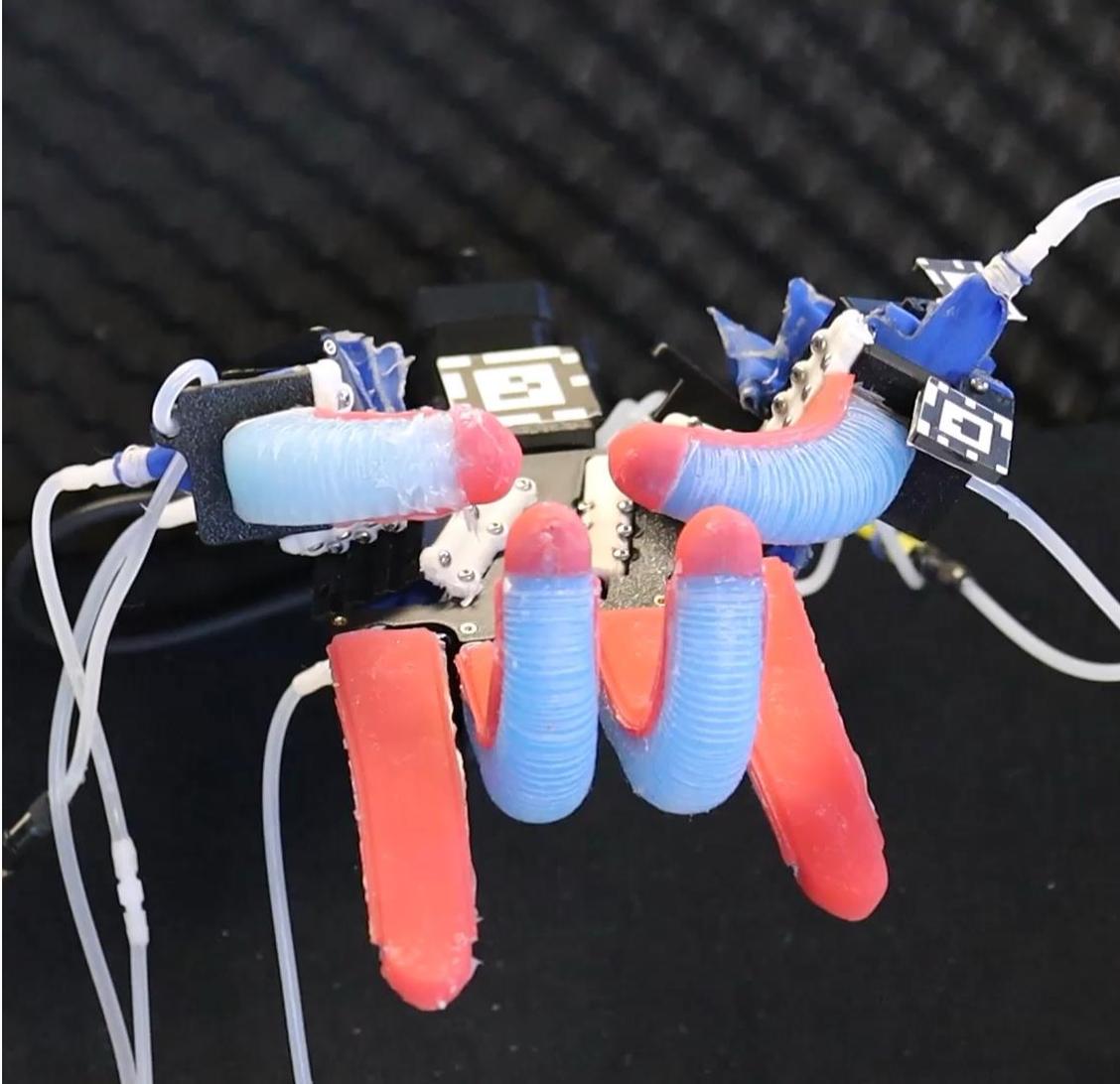
Sieler, Brock.
“Dexterous soft
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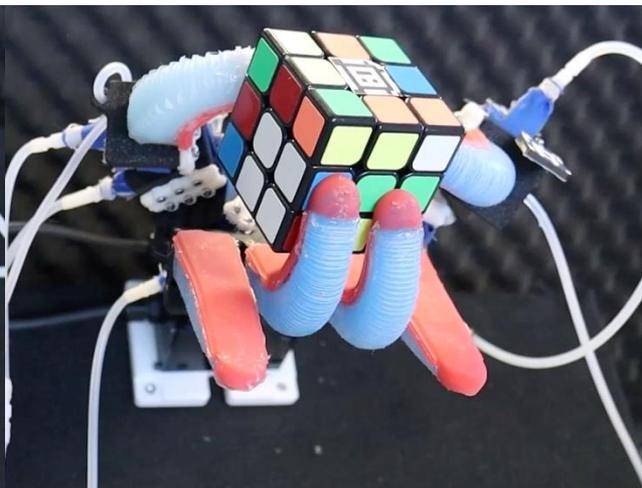
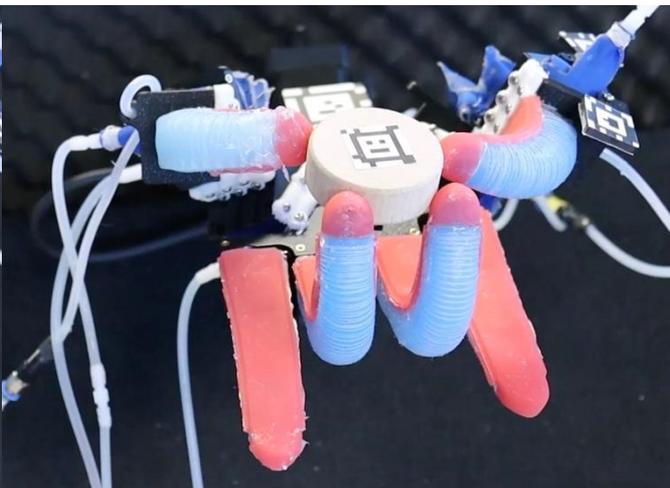
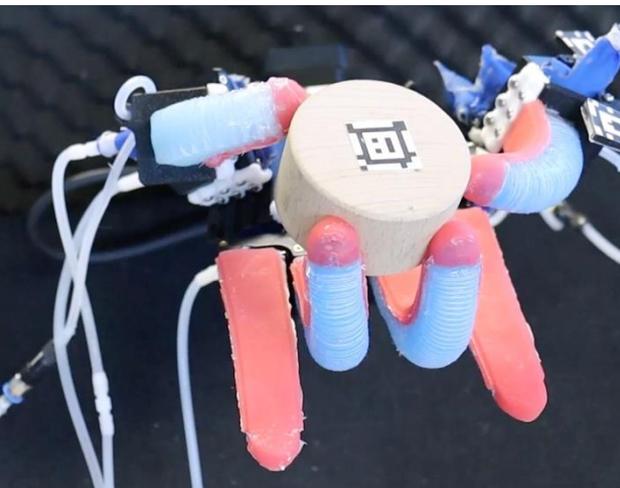
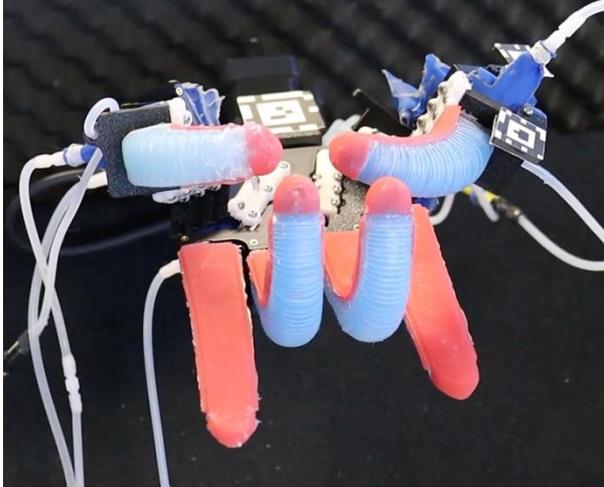
What are we working on now?



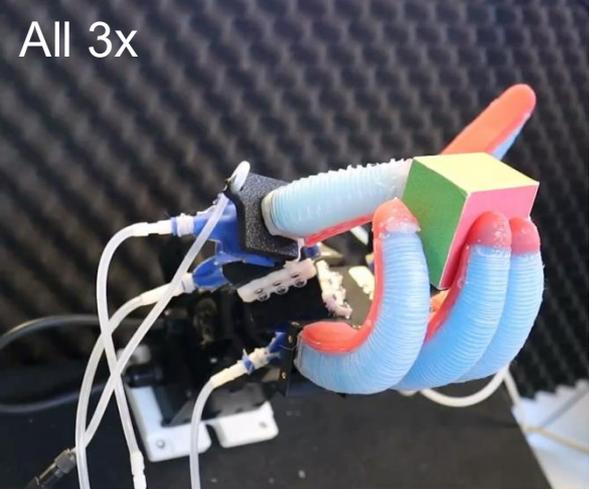


See Equilibrium Point Hypothesis

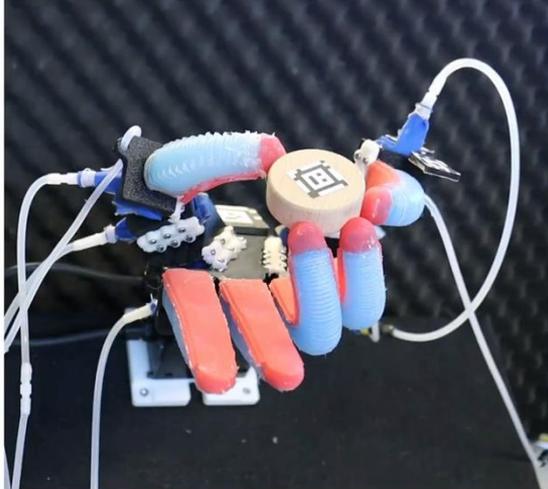
A. Feldman and M. Levin,
“The equilibrium-point hypothesis – past, present and future,” *Advances in experimental medicine and biology*, 2009



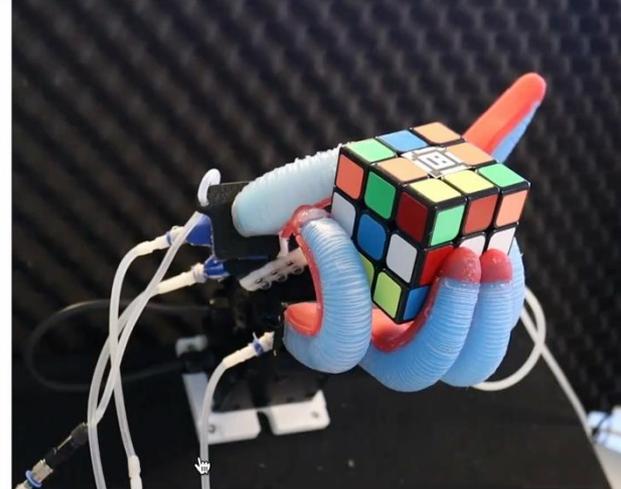
All 3x



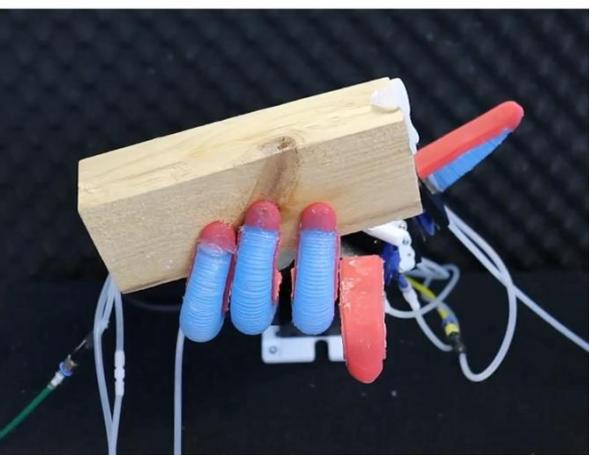
X



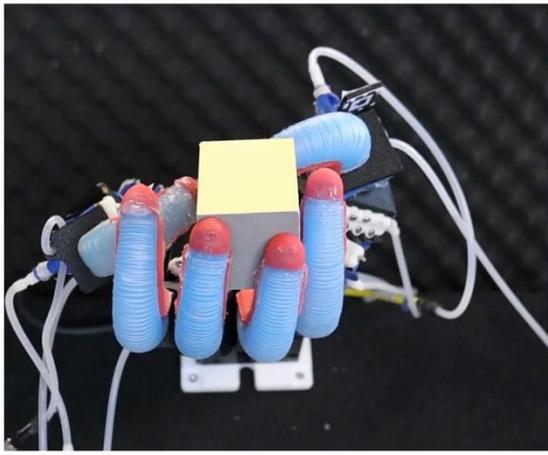
Y



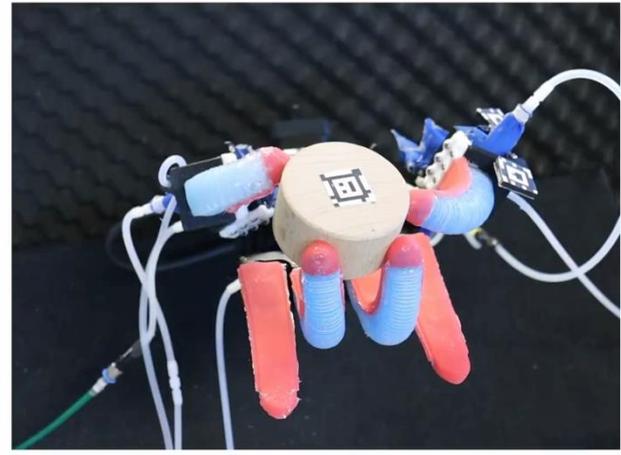
Z



Roll



Pitch



Yaw



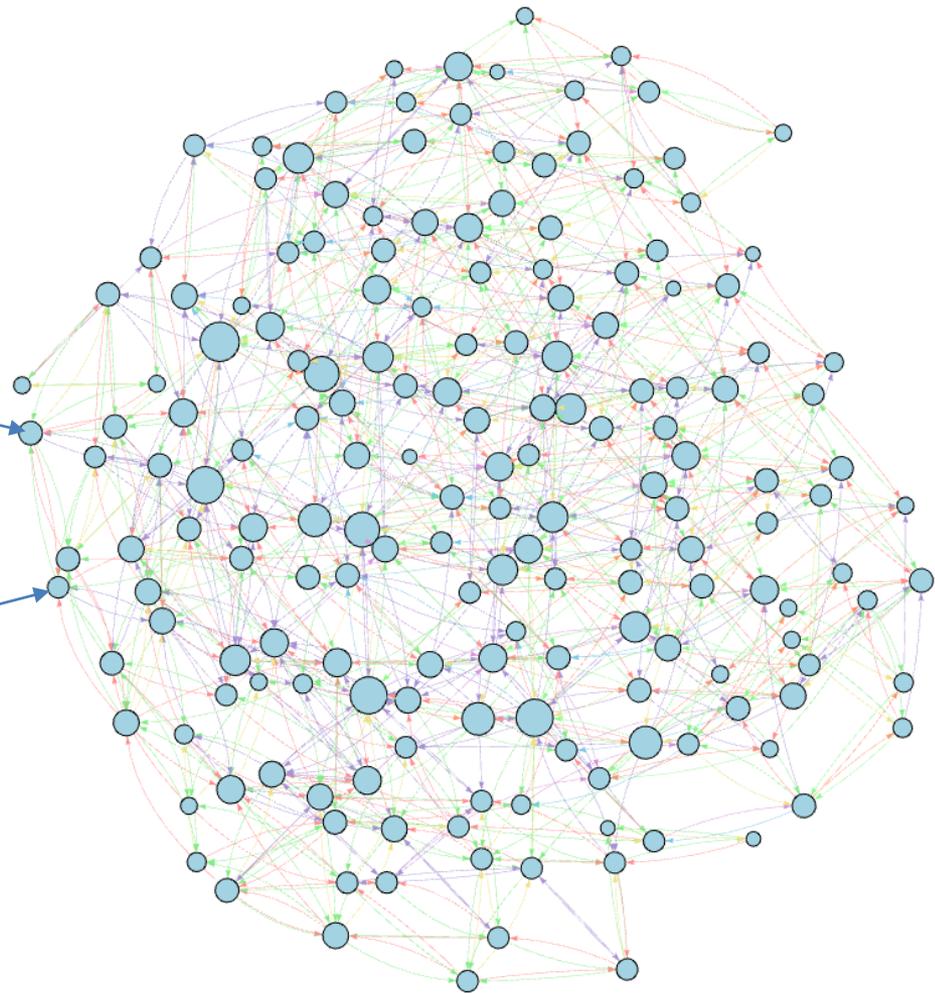
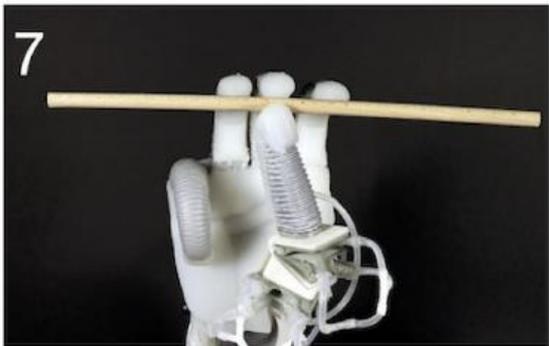
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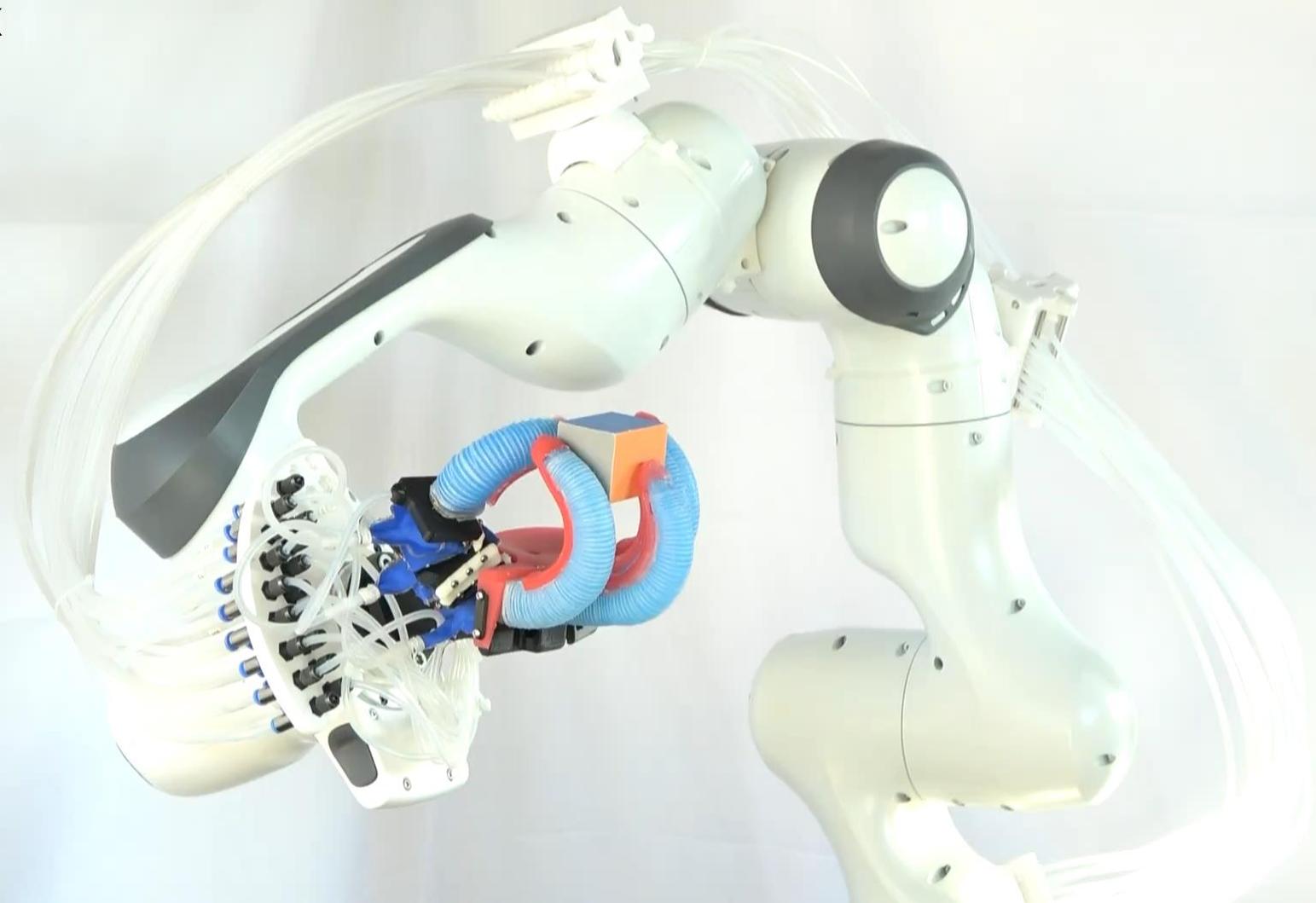
6



7



Speed 4x



Softie Instructions

In Case of an Experiment



Turn of gravity



Don't repeat tests



Record first trial....it is also the last



Writing a Paper



Choose realistic application ...



...or beyond applications



Declare as industry ready



and inherently safe

Designing a Soft Robot



Redefine precision (+/- 5 cm)



Replace working designs with soft ones

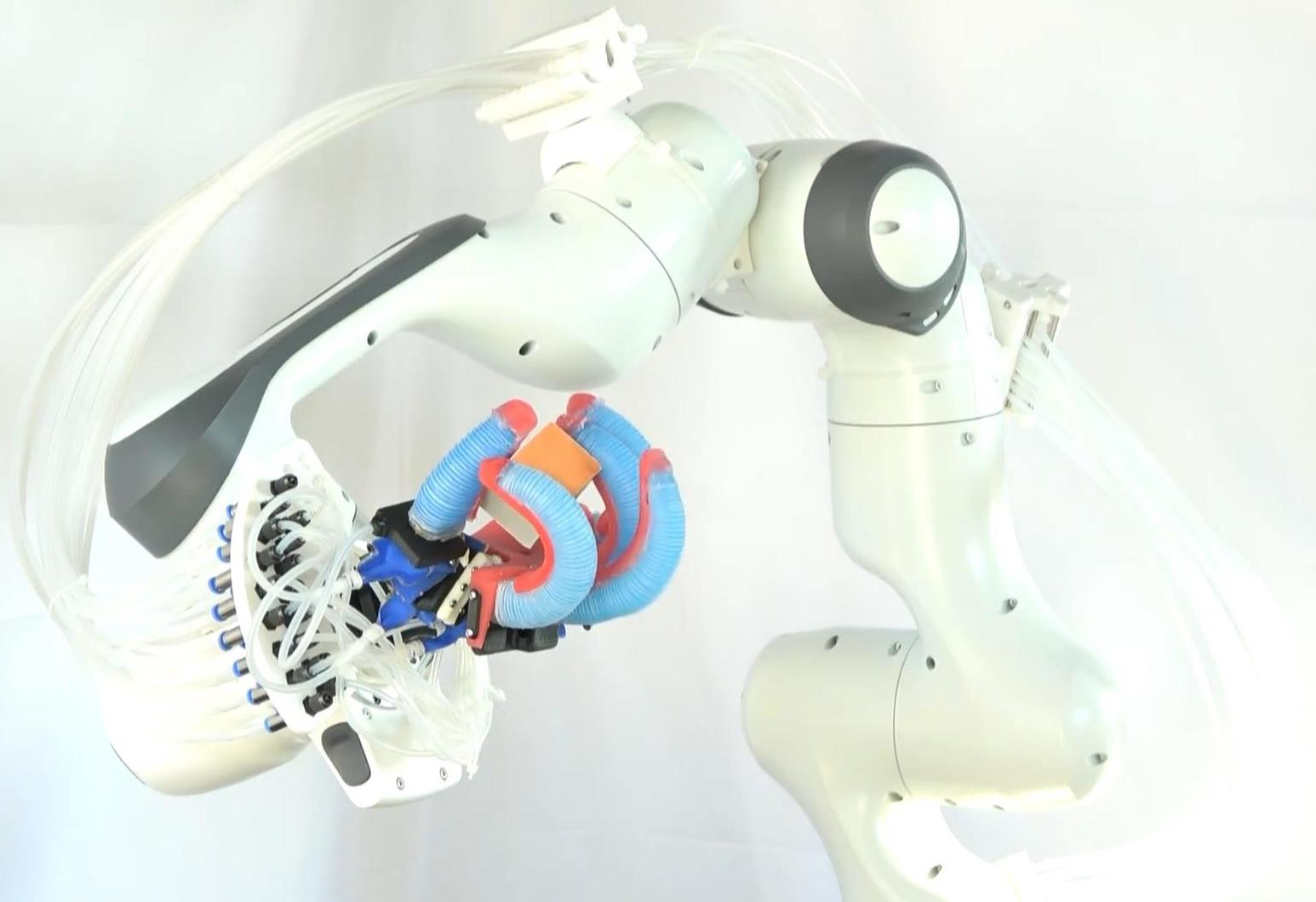


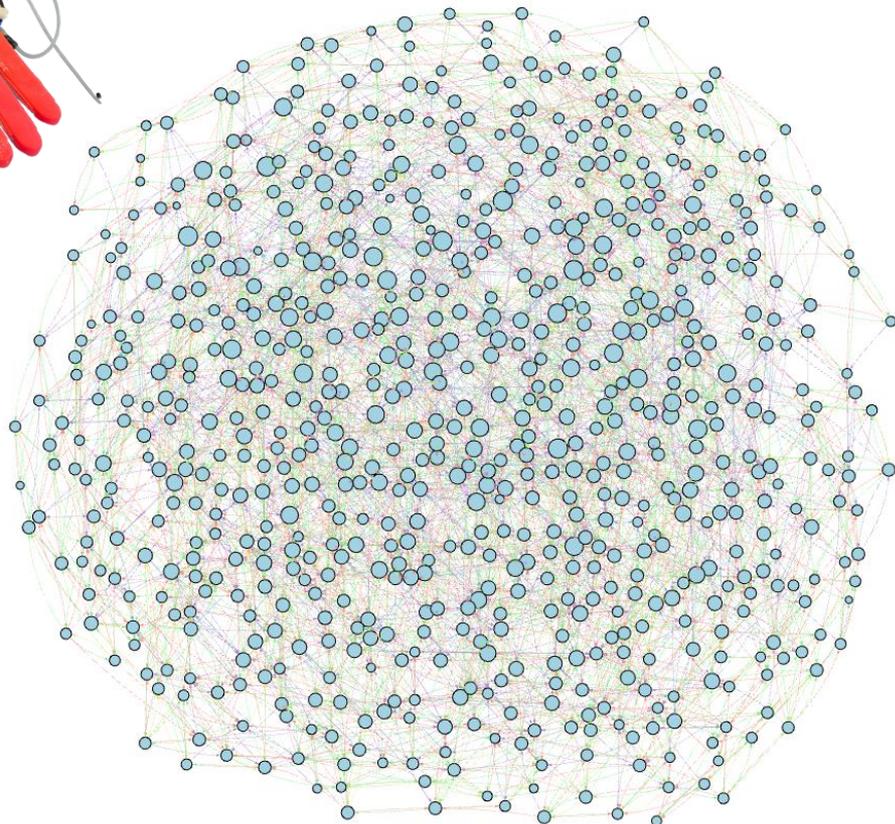
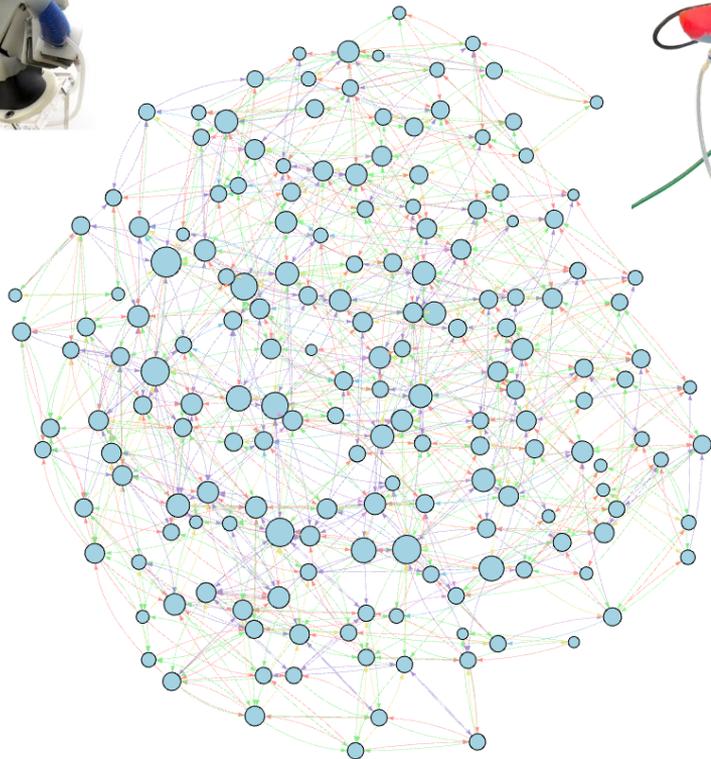
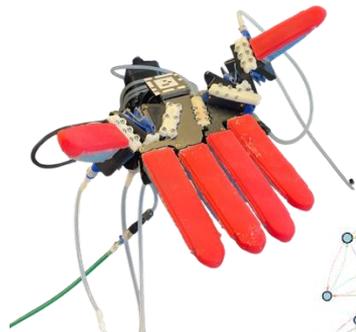
Make up requirements that fit the design



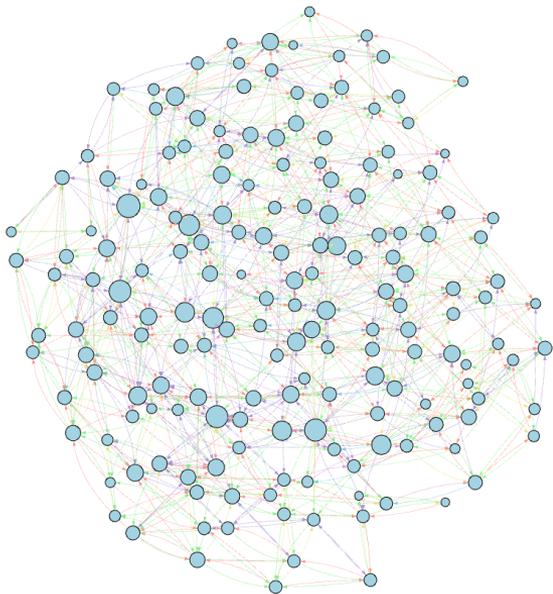
Cover everything in silicone during manufacturing

Speed 4x





What will we work on?



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Morphology

Control

