

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

Alexander Koenig
Robotics and Biology Laboratory



What happened so far?

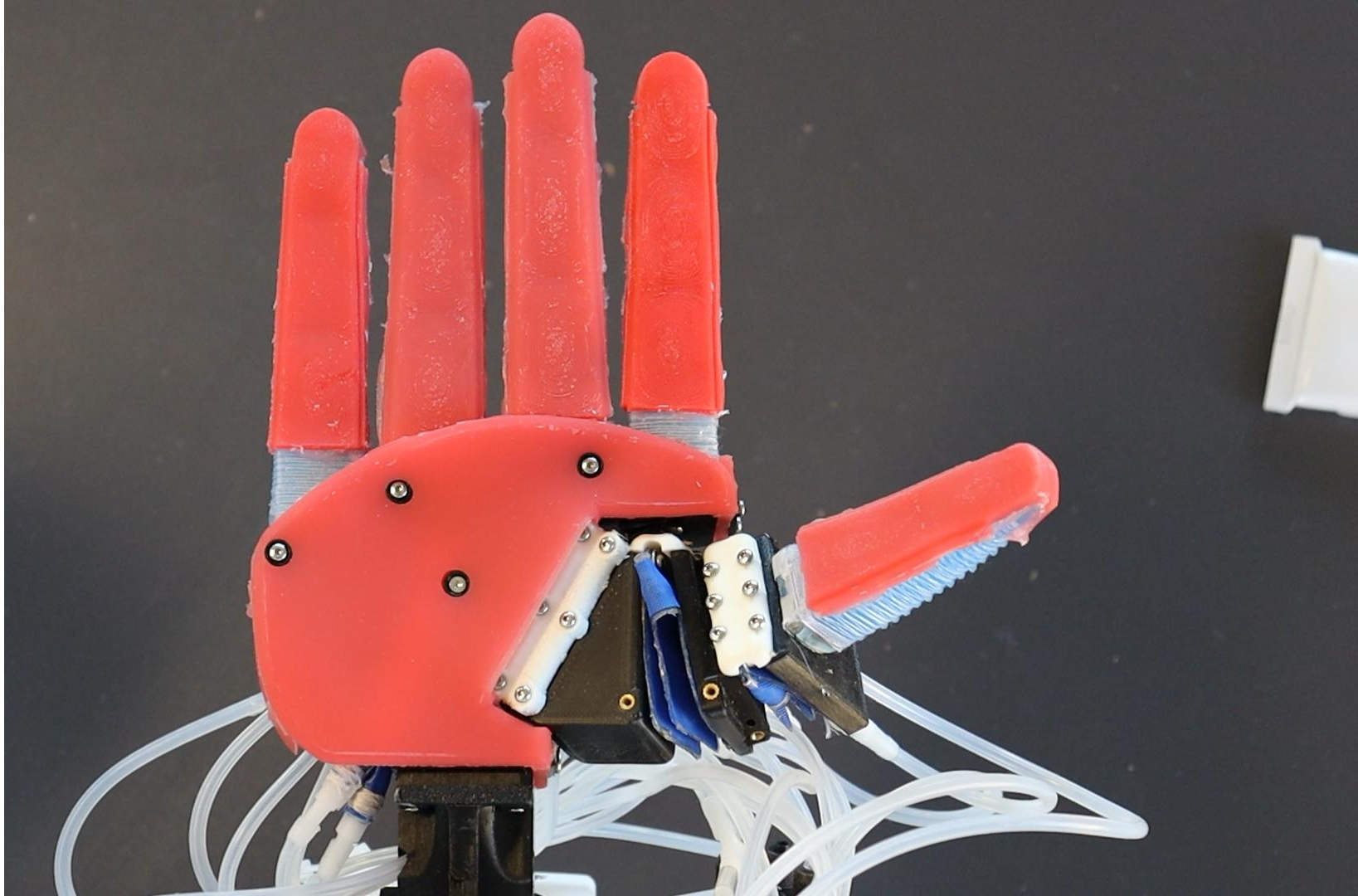


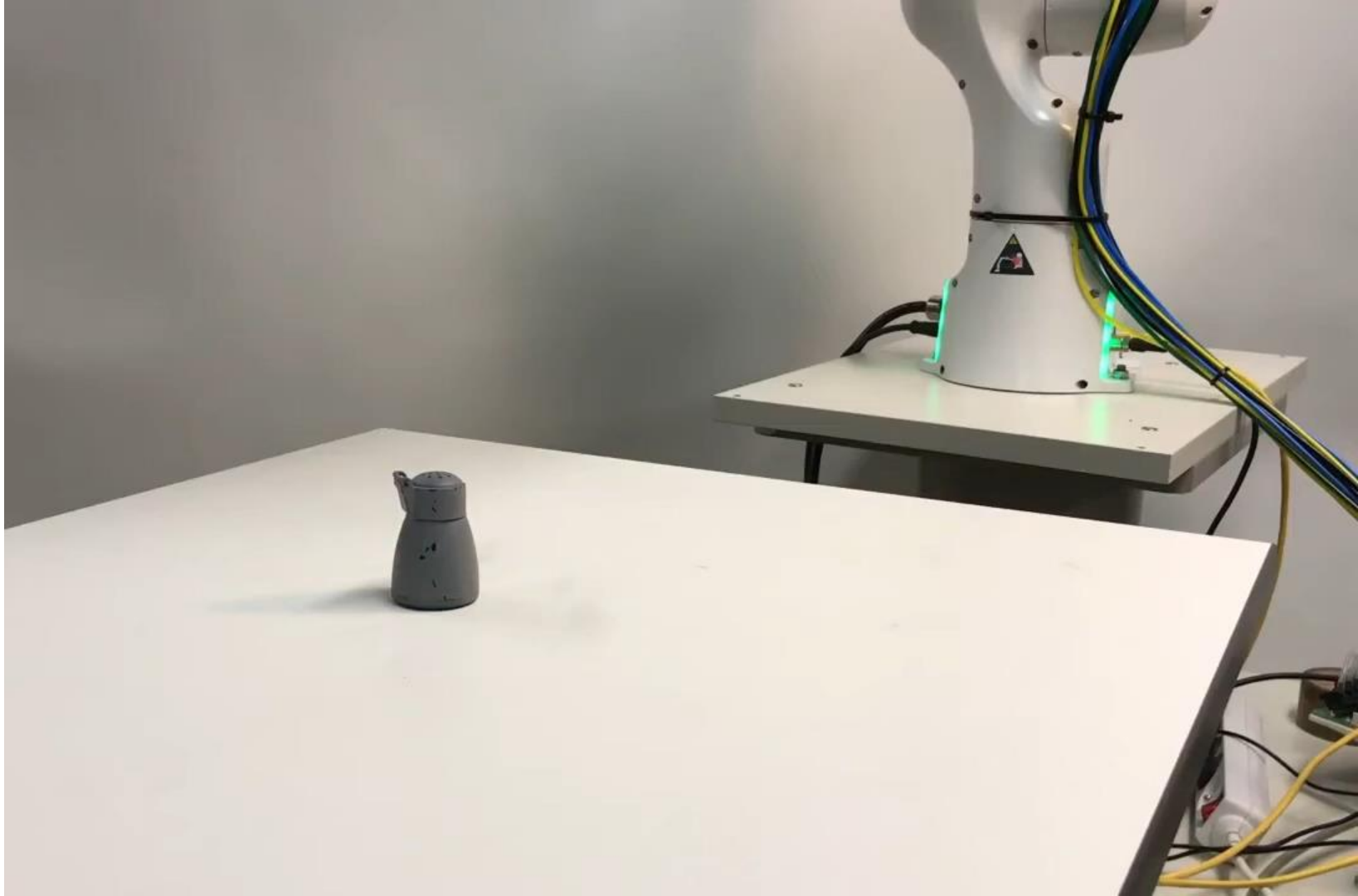
Morphology

Control



**Puhlmann,
Harris, Brock.**
“RBO Hand 3: A
Platform for Soft
Dexterous
Manipulation” in
TRO 2022

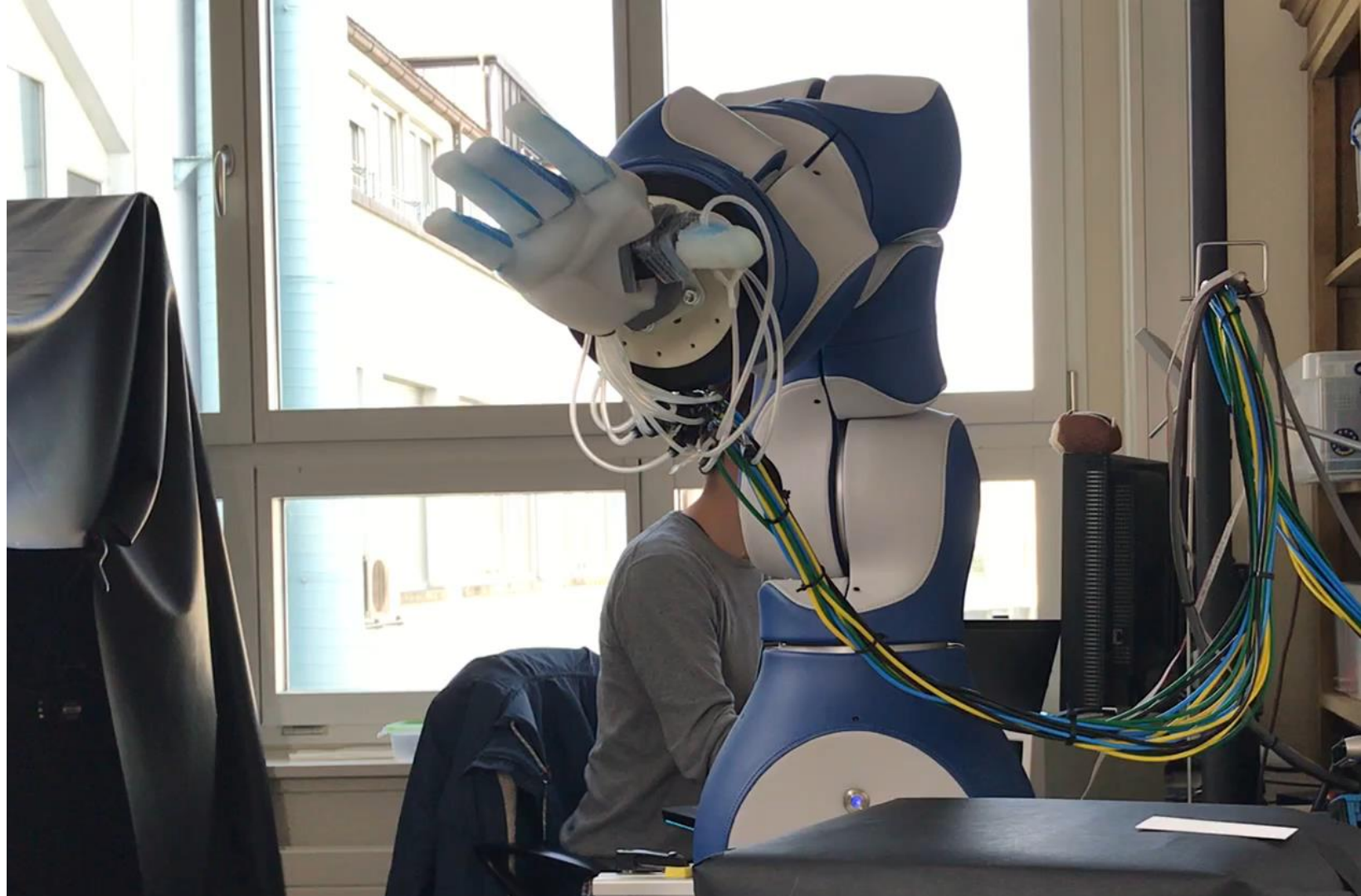




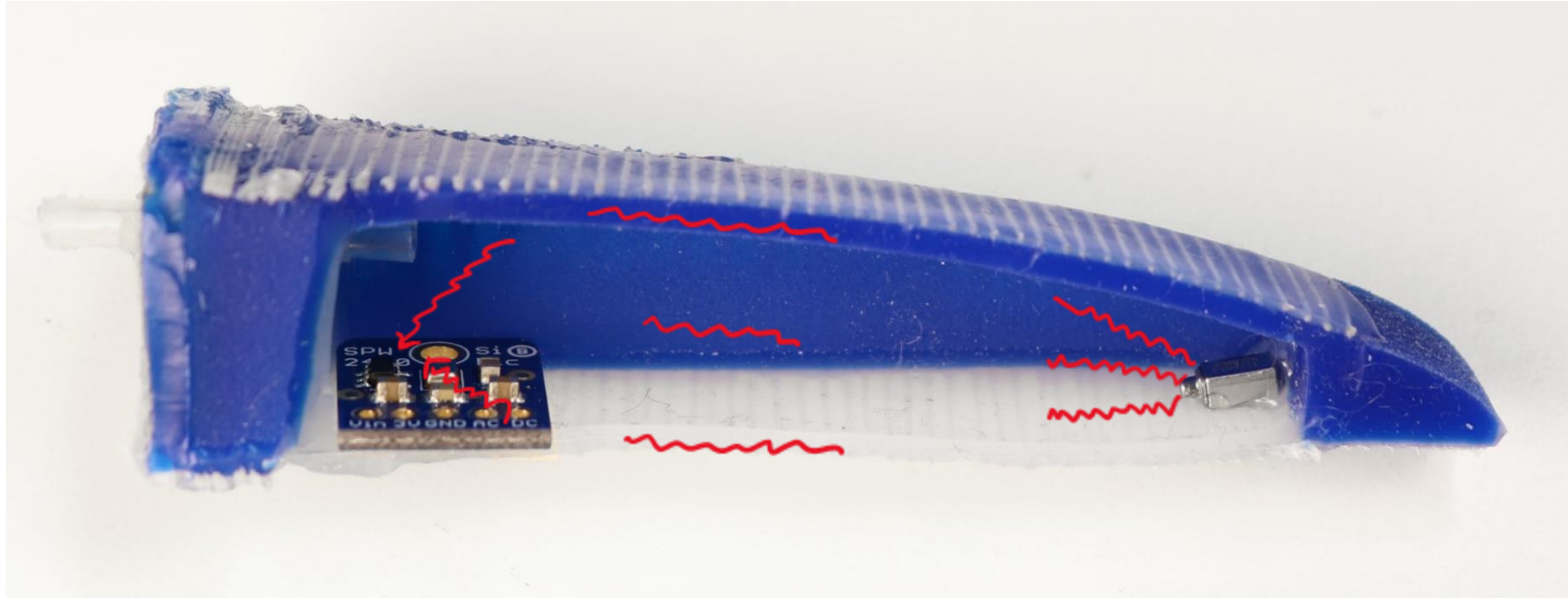
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(Acoustic) Morphological Sensing

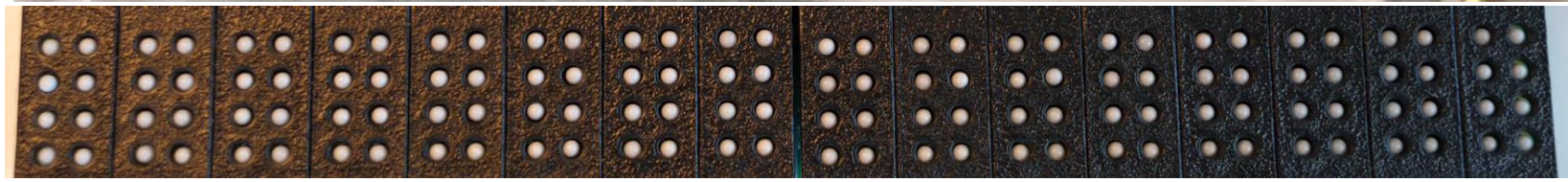
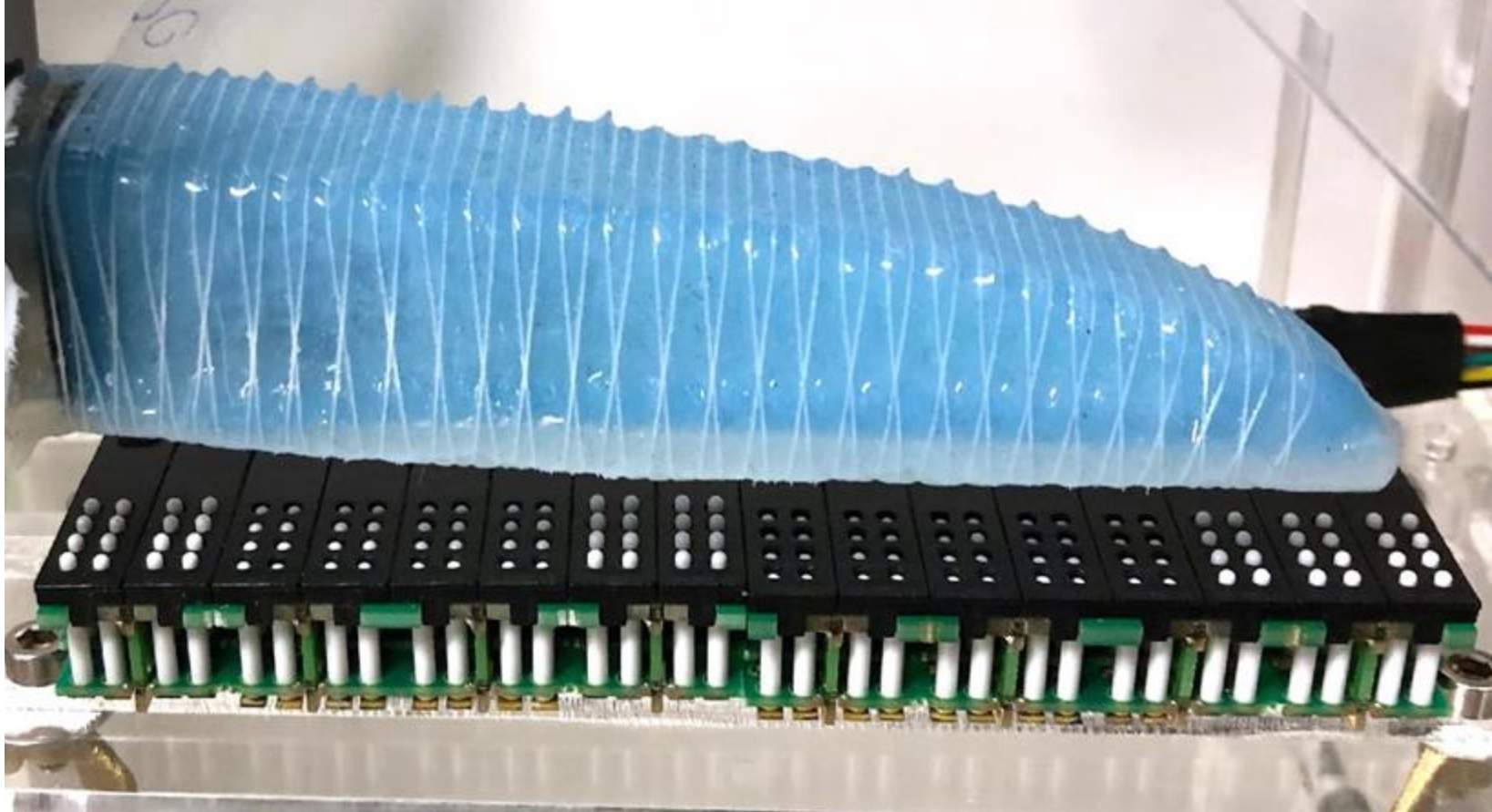


**Wall, Zöller,
Brock.** "Passive
and Active
Acoustic Sensing
for Soft
Pneumatic
Actuators" in
IJRR 2022

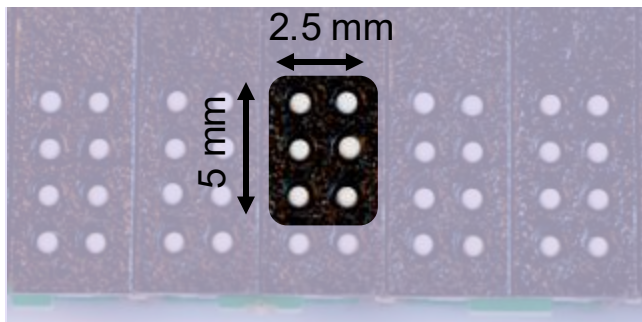
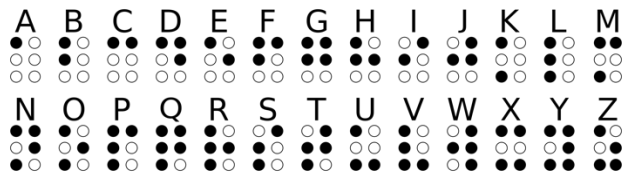


www.wildfilmsindia.com

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



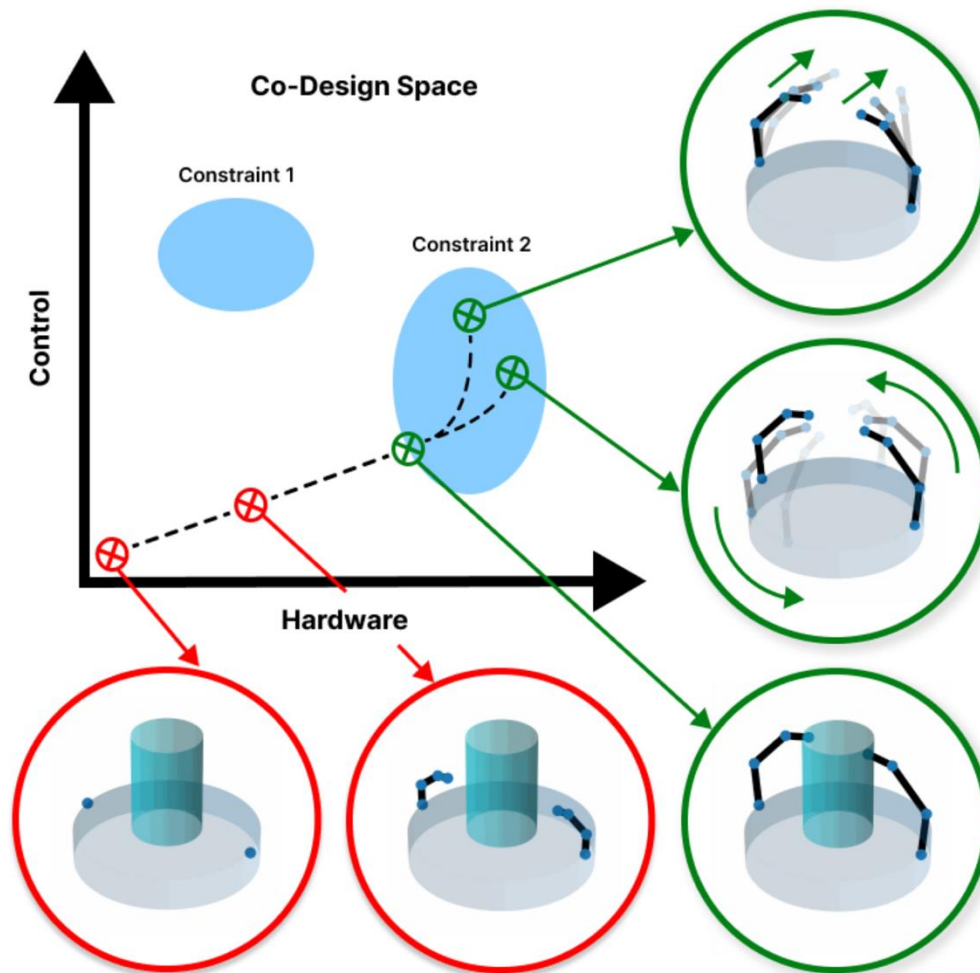
**Wall, Zöller,
Brock.**

“A
Method for
Sensorizing Soft
Actuators and Its
Application to the
RBO Hand 2” in
ICRA 2017

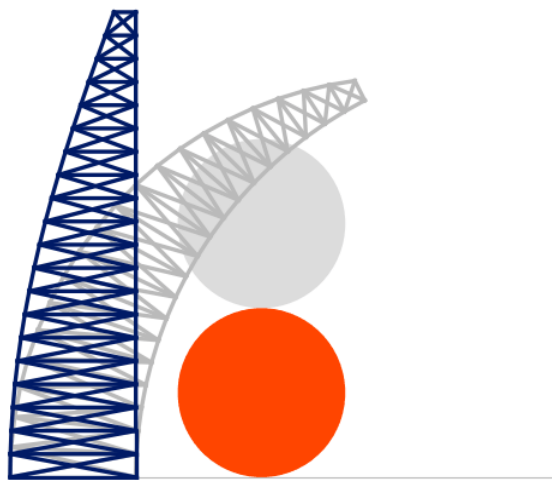


**Pannen,
Puhlmann,
Brock.** “A Low-
Cost, Easy-to-
Manufacture,
Flexible, Multi-
Taxel Tactile
Sensor and its
Application to In-
Hand Object
Recognition” in
ICRA 2022.



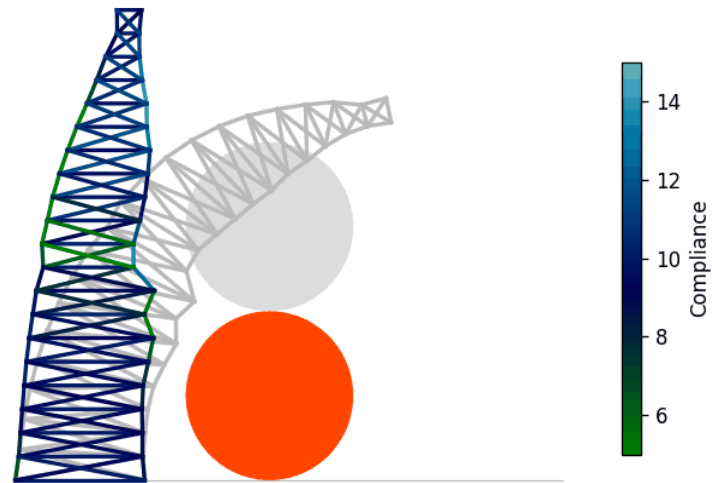


Vaish, Brock.
"Co-Designing
Manipulation
Systems Using
Task-Relevant
Constraints" in
ICRA 2024



Object Target

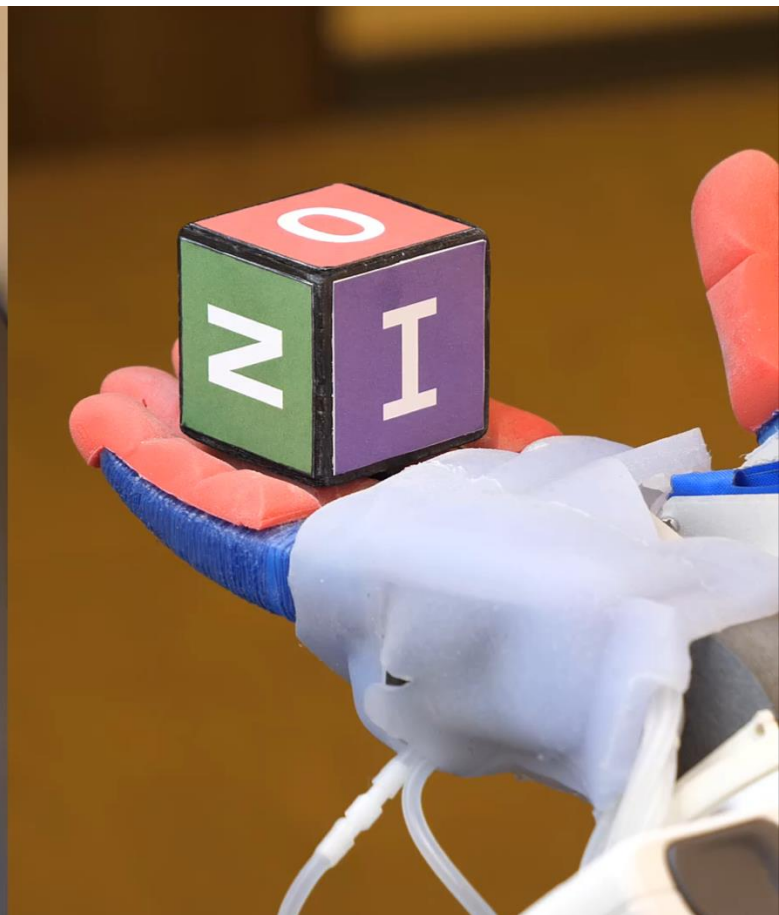
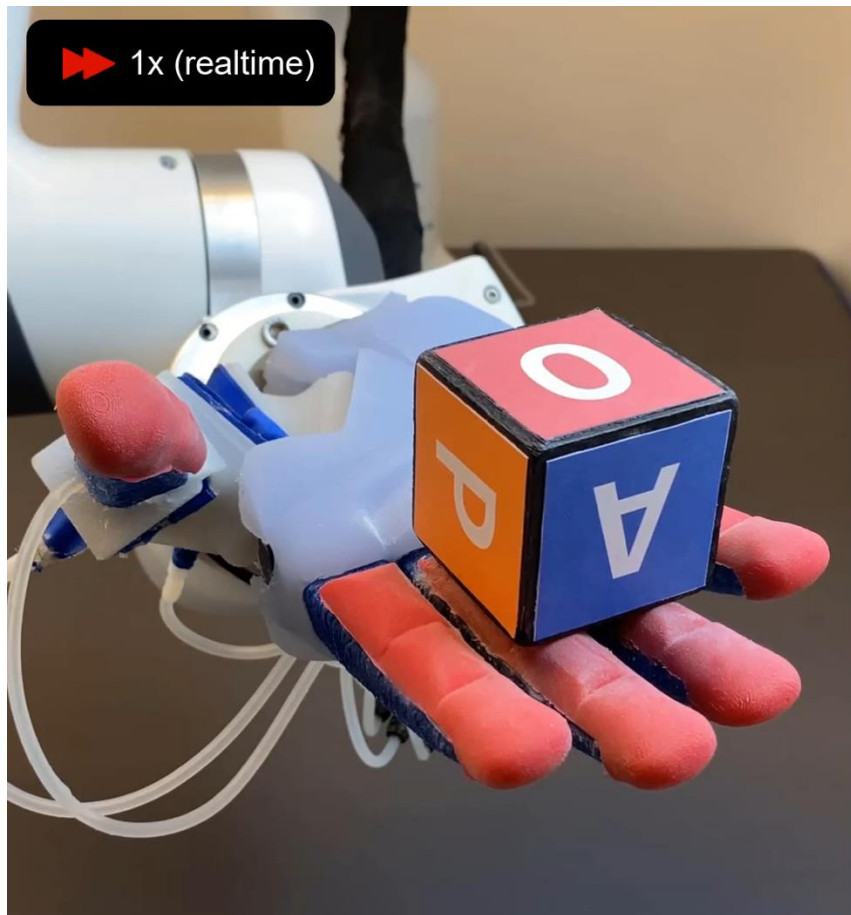
Iteration 0



Object Target

Iteration 100

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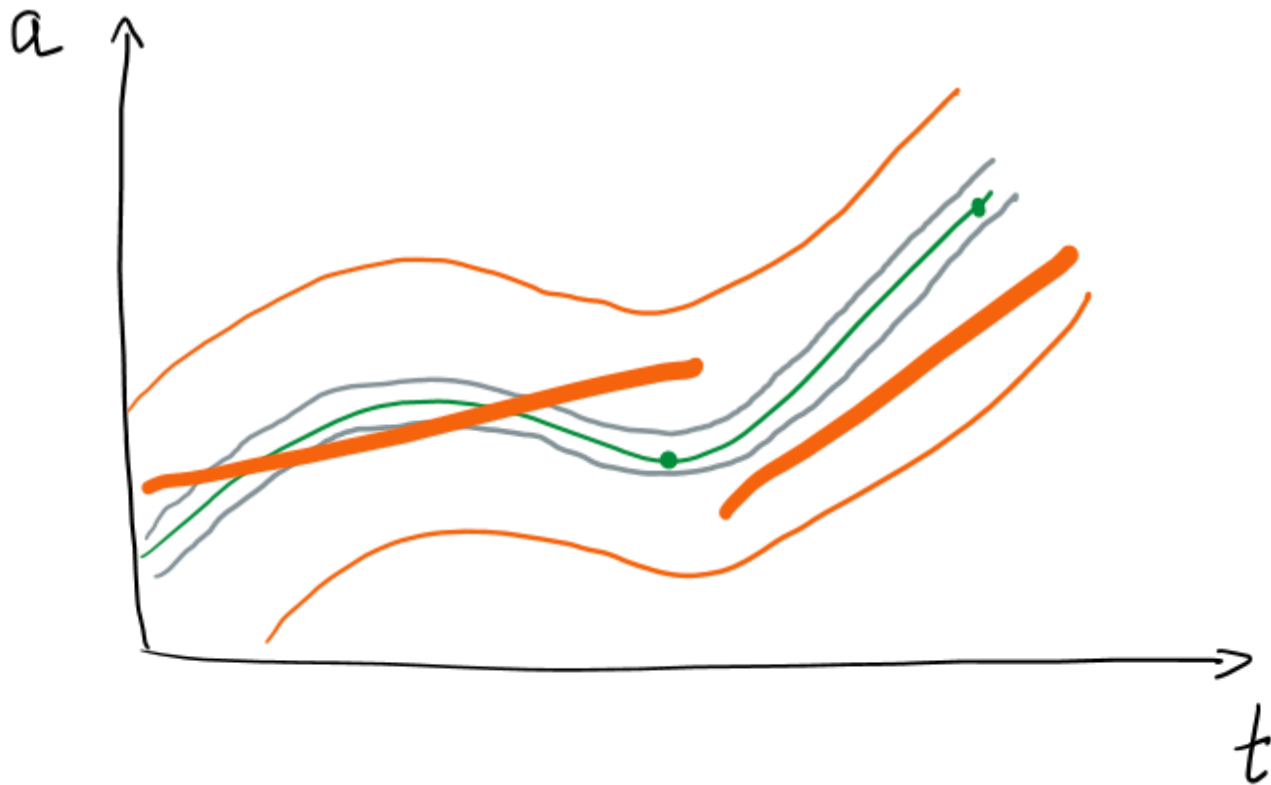
**Bhatt, Sieler,
Puhlmann,
Brock.**
“Surprisingly
Robust In-Hand
Manipulation: An
Empirical Study”
in RSS 2021

Learning a Manipulation Skill within Seconds

Leveraging Demonstration, Compliance,
Exploration and Feedback

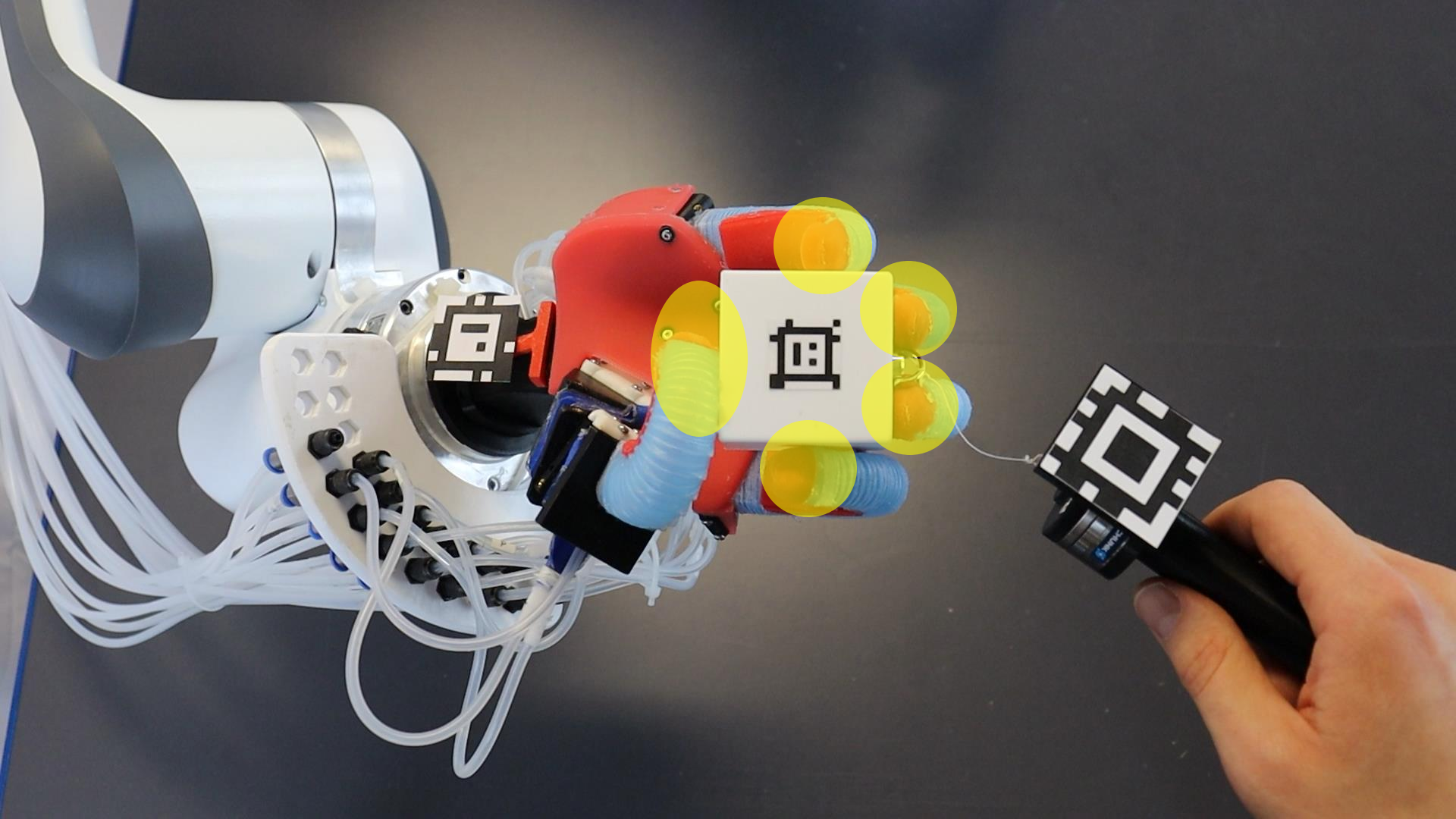
Sieler, Brock.

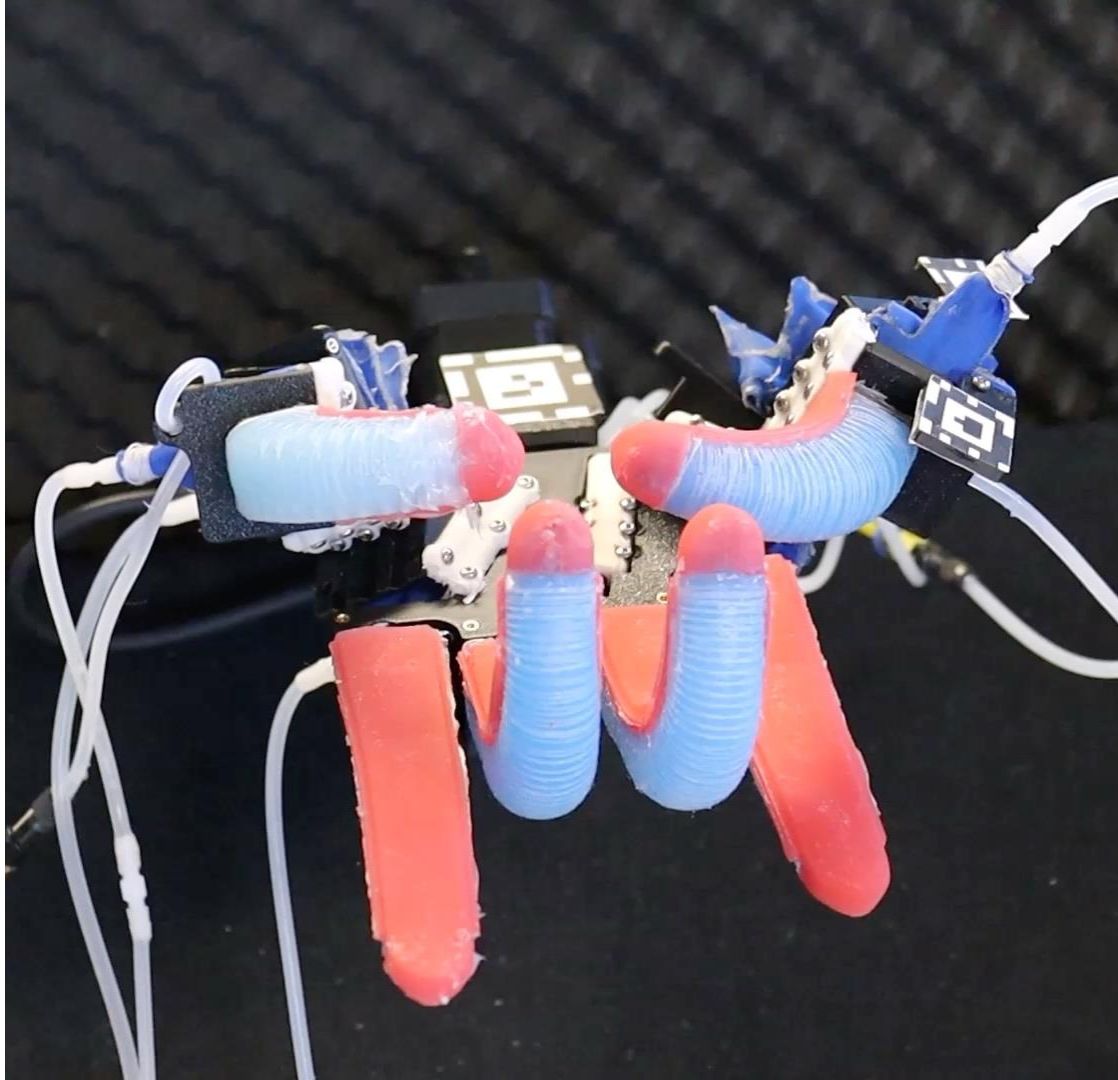
“Dexterous soft
hands linearize
feedback-control
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IROS 2023



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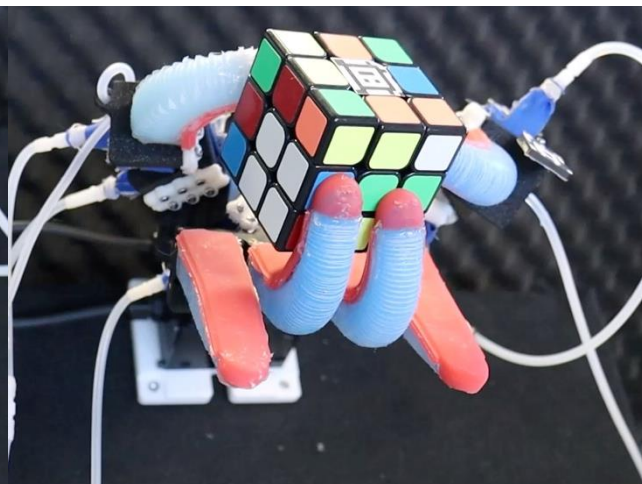
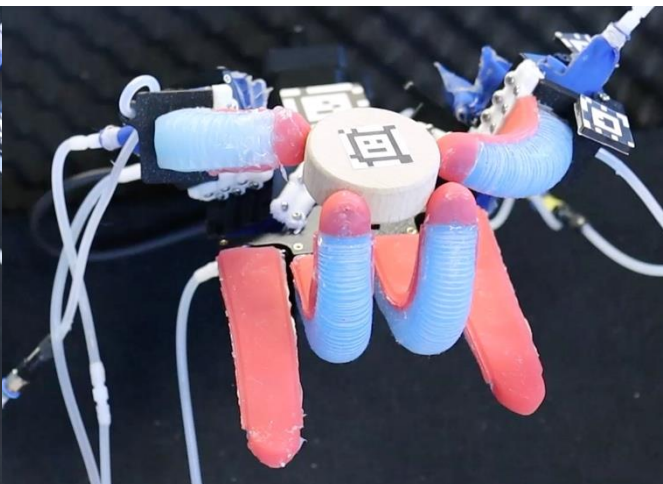
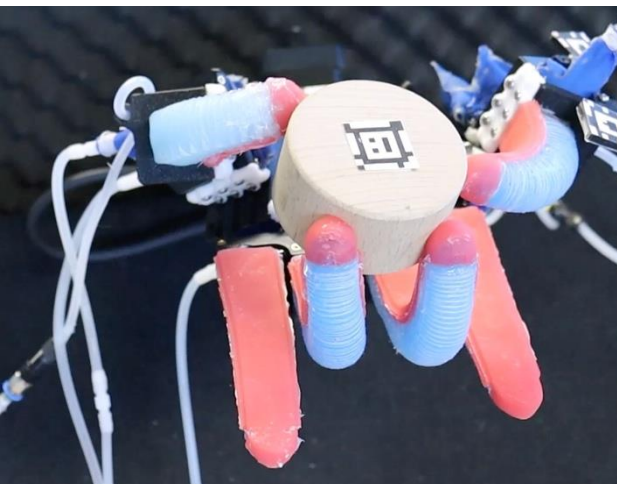
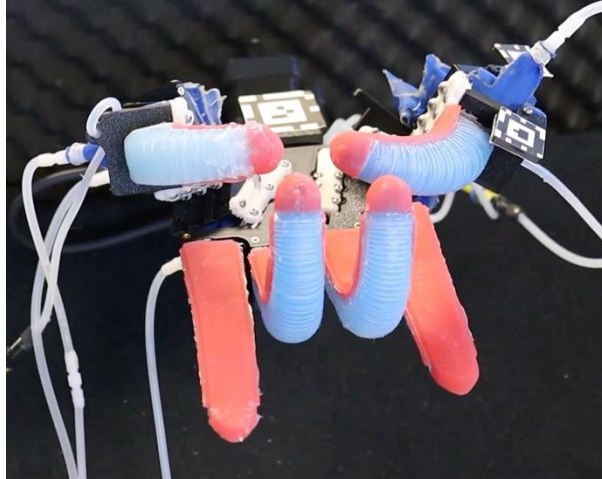
What are we working on now?



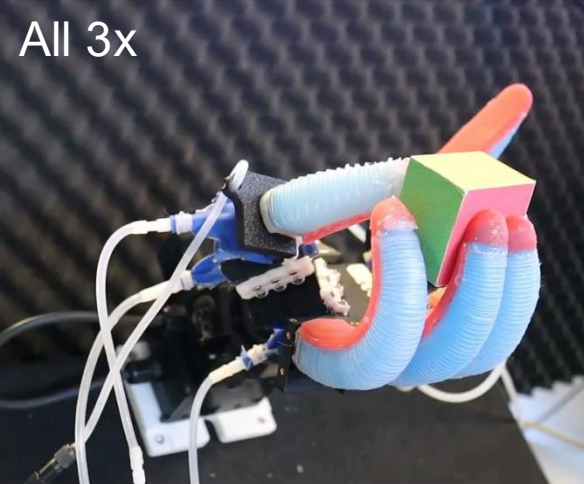


See Equilibrium Point Hypothesis

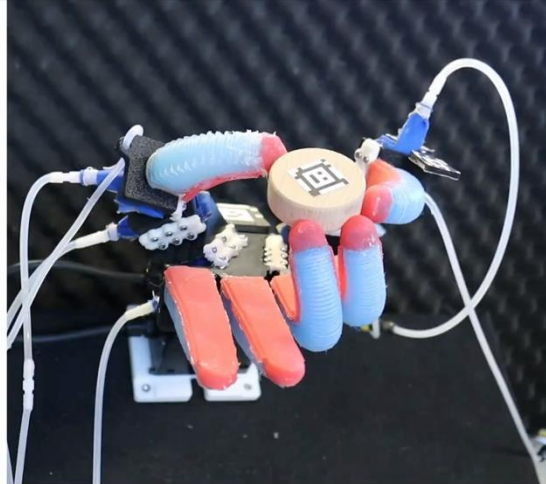
A. Feldman and M. Levin,
“The equilibrium-point hypothesis – past, present and future,” *Advances in experimental medicine and biology*, 2009



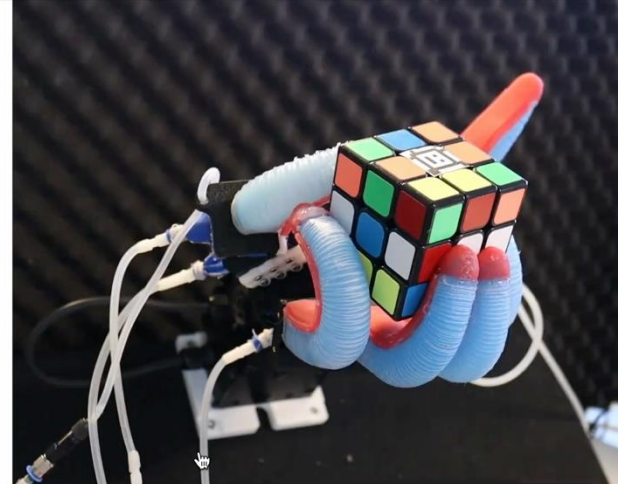
All 3x



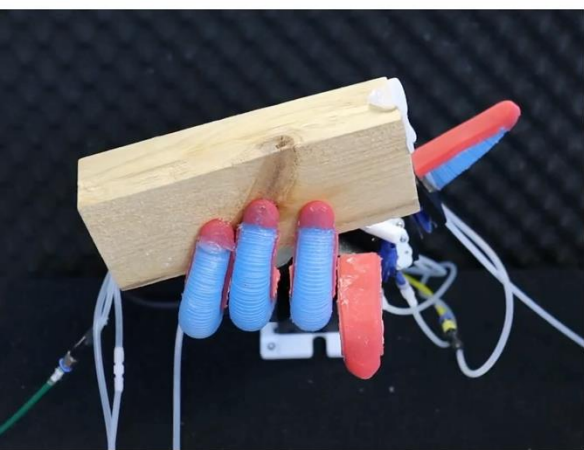
X



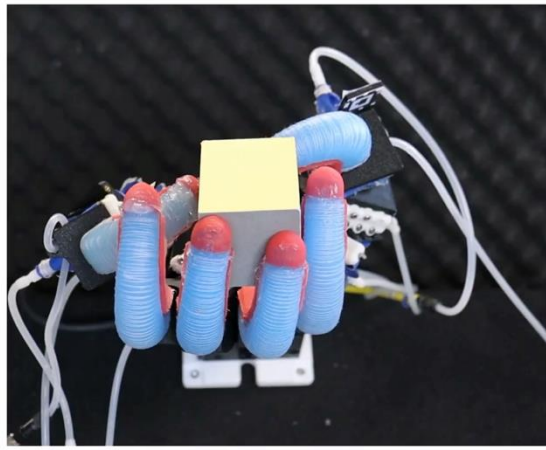
Y



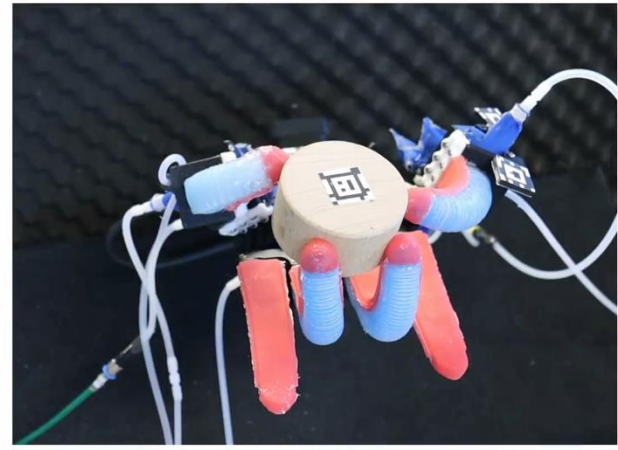
Z



Roll



Pitch

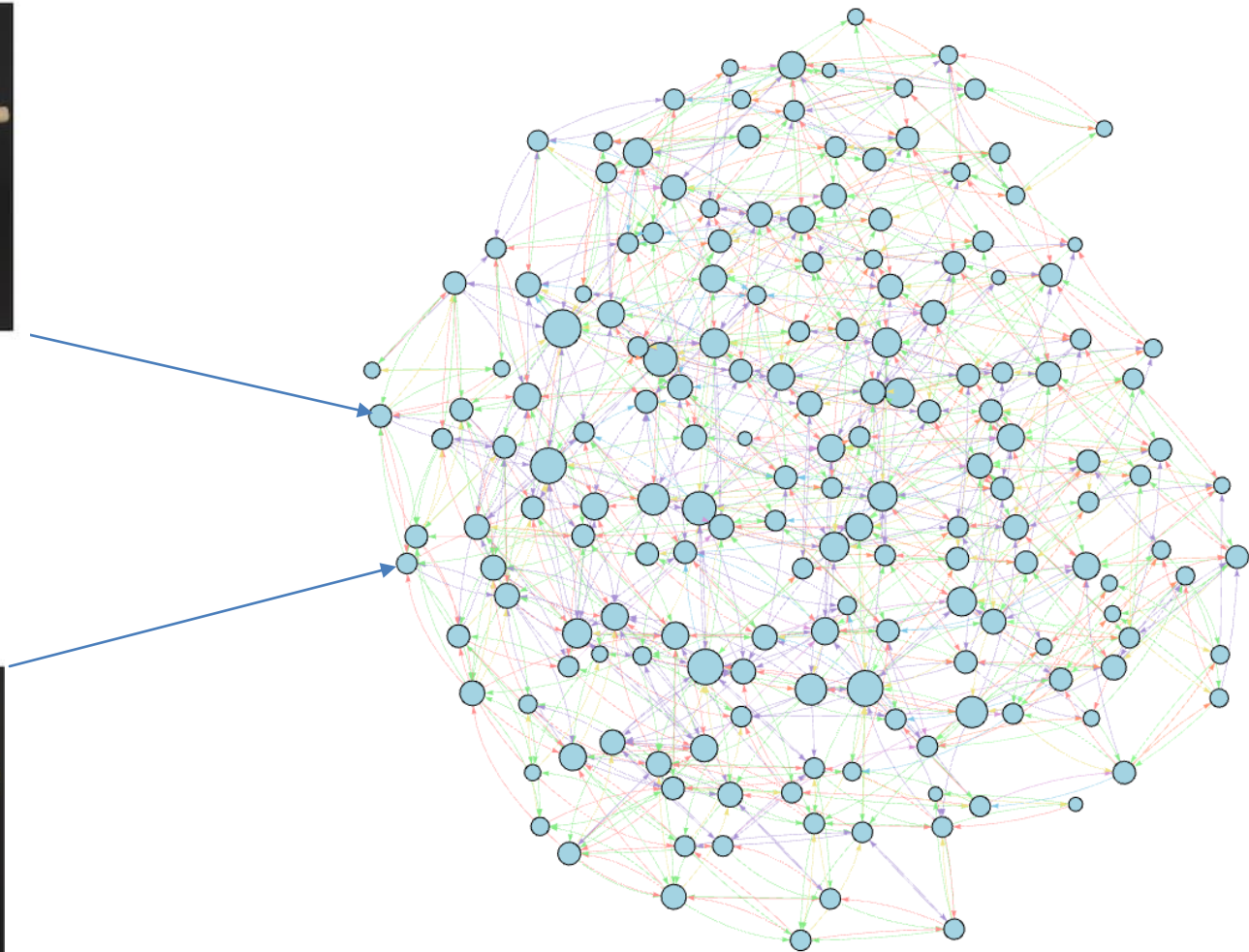
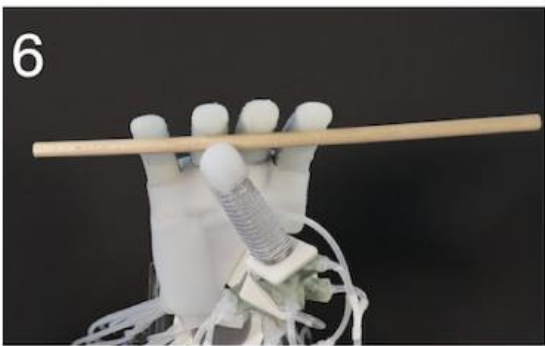


Yaw

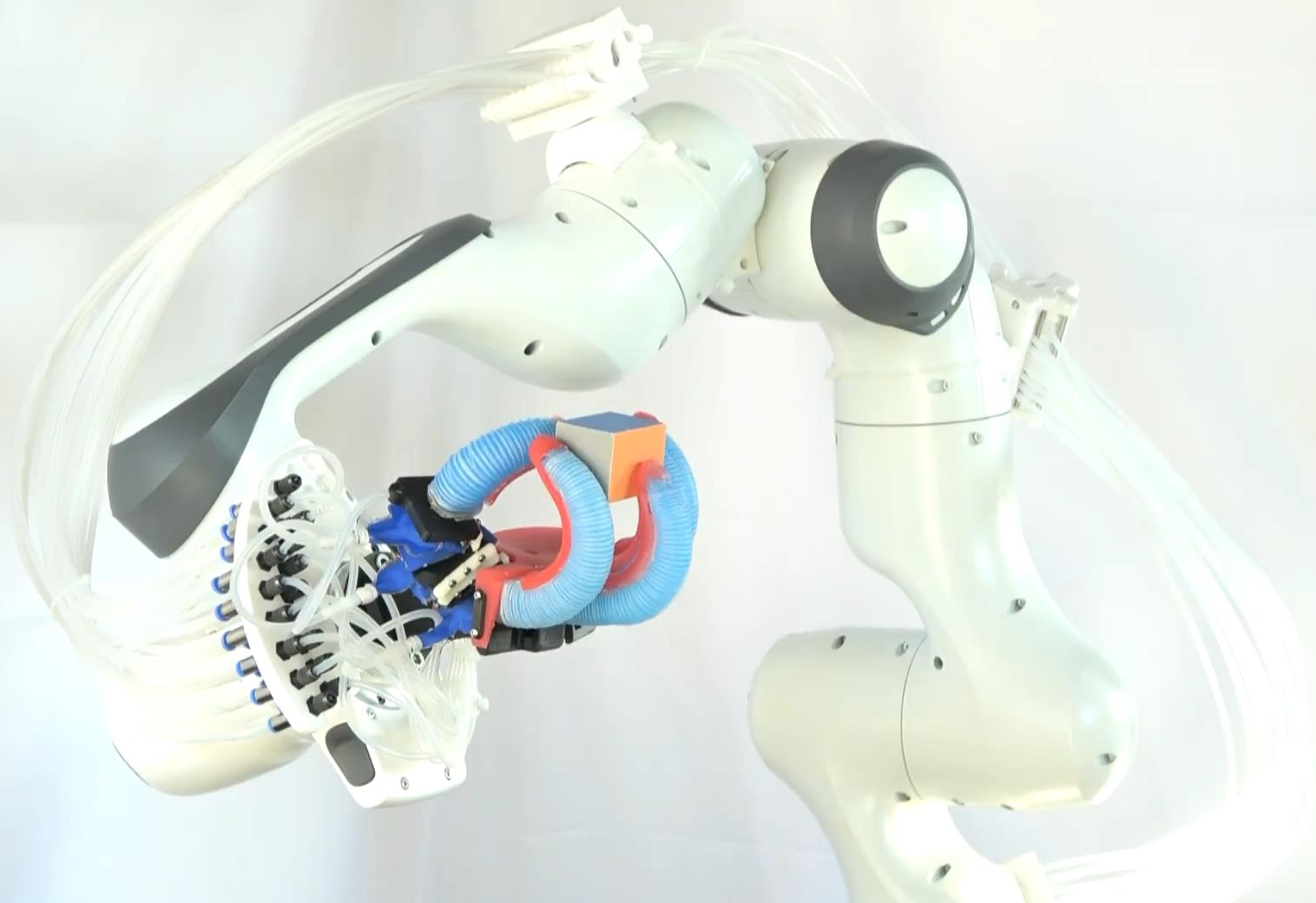


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Speed 4x



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

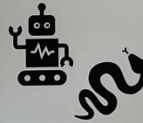


and inherently safe

Designing a Soft Robot



Redefine precision
(+/- 5 cm)



Replace working designs
with soft ones

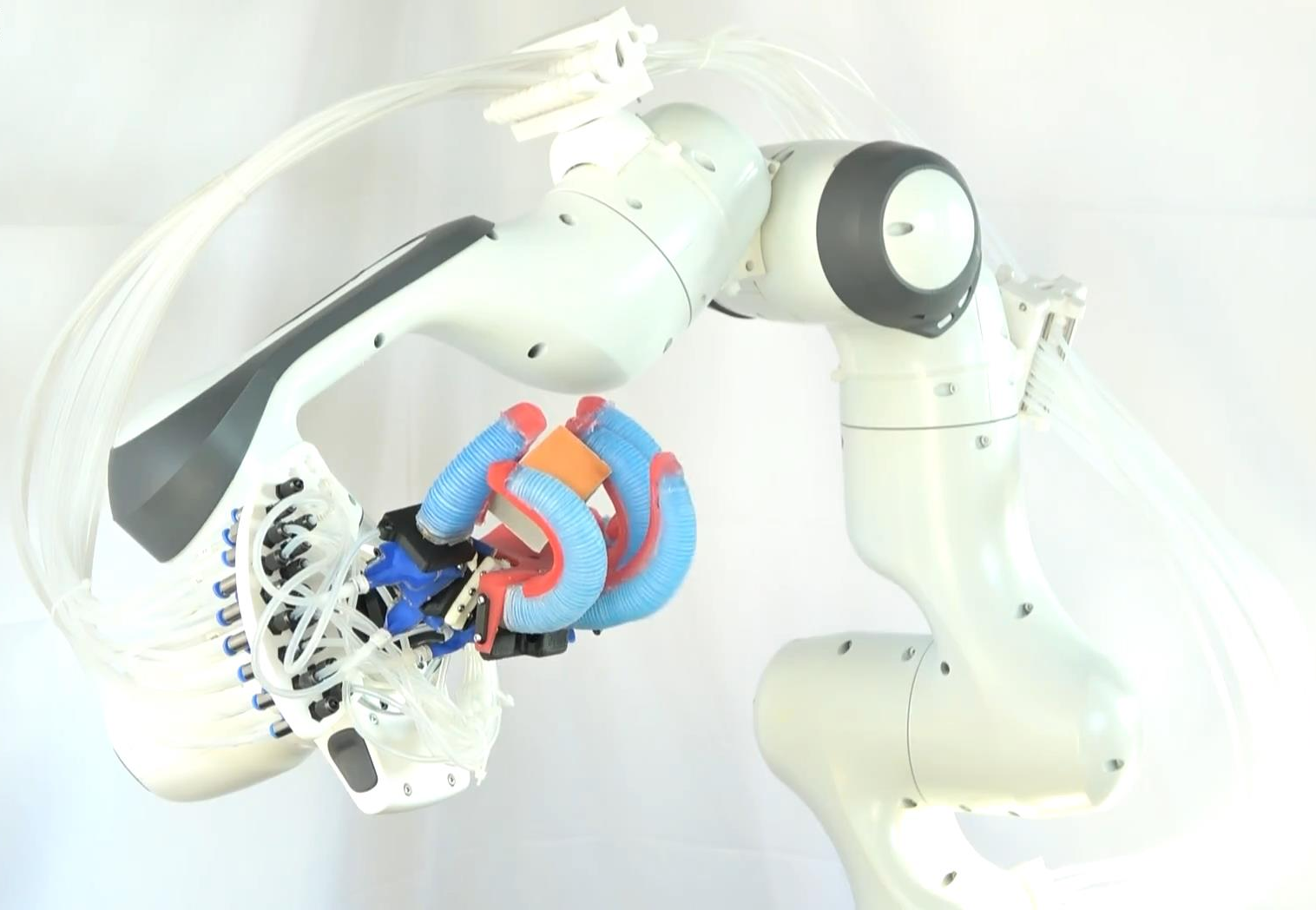


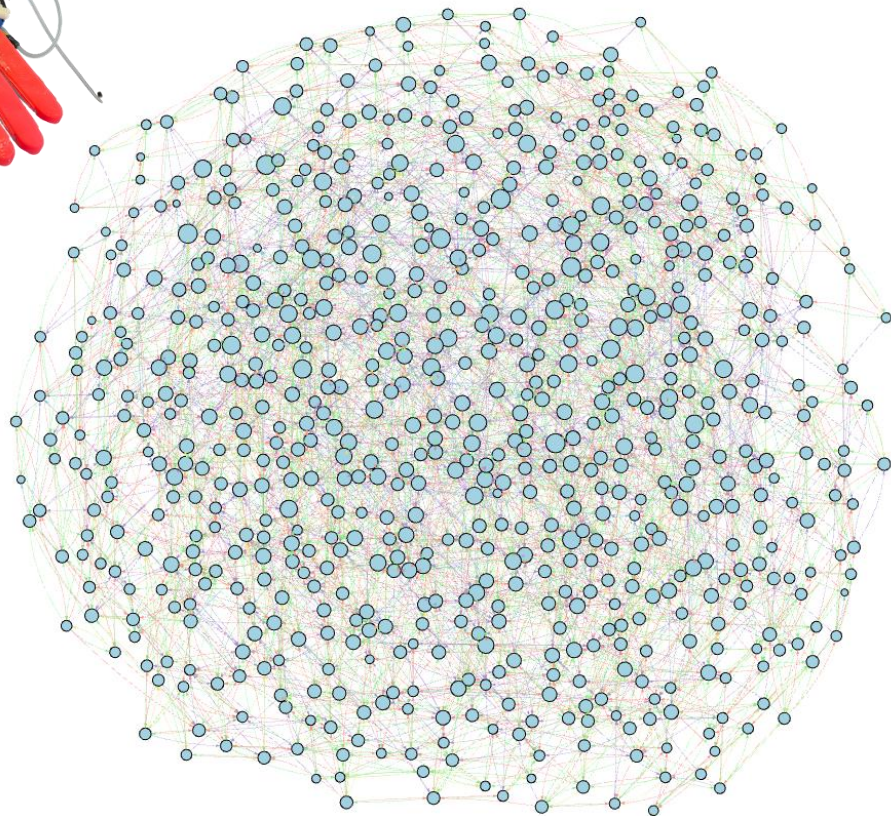
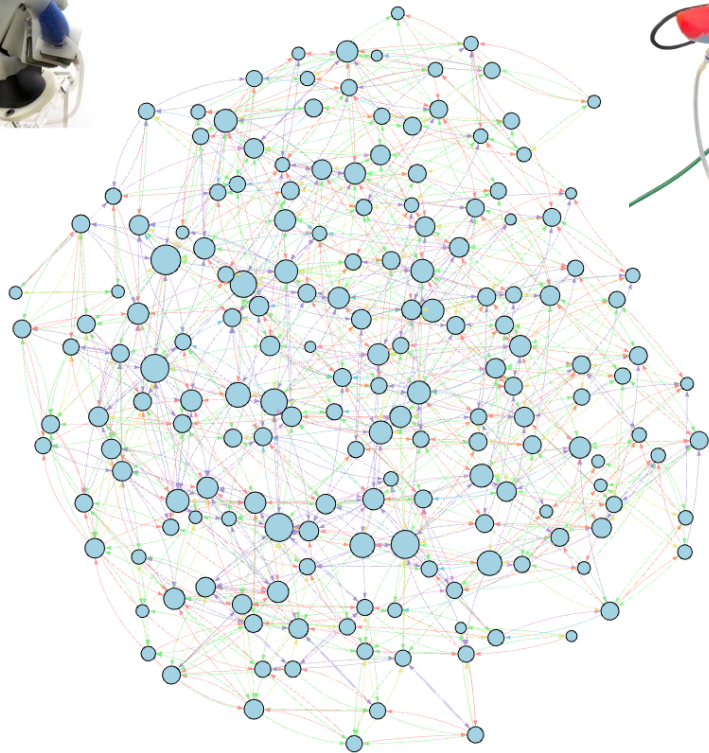
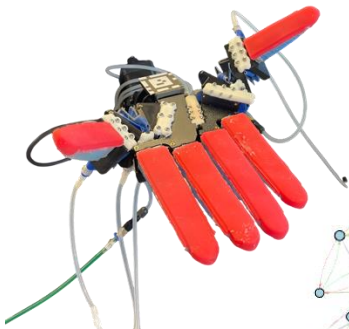
Make up requirements
that fit the design



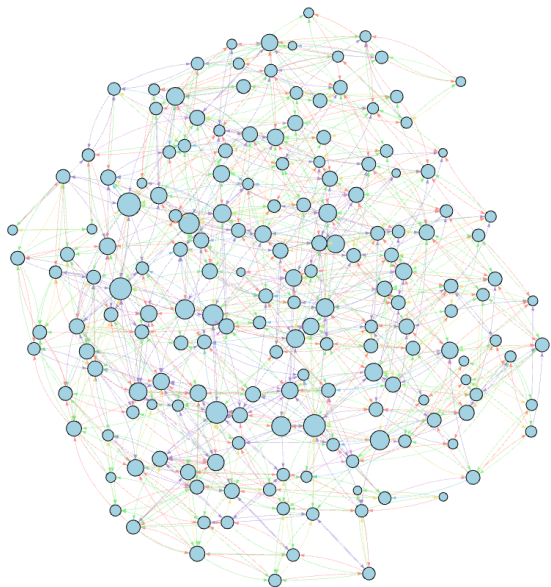
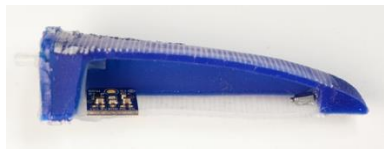
Cover everything
in silicone during
manufacturing

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Cover everything in silicone during manufacturing



Morphology

Control

