Sorry for not being with you!

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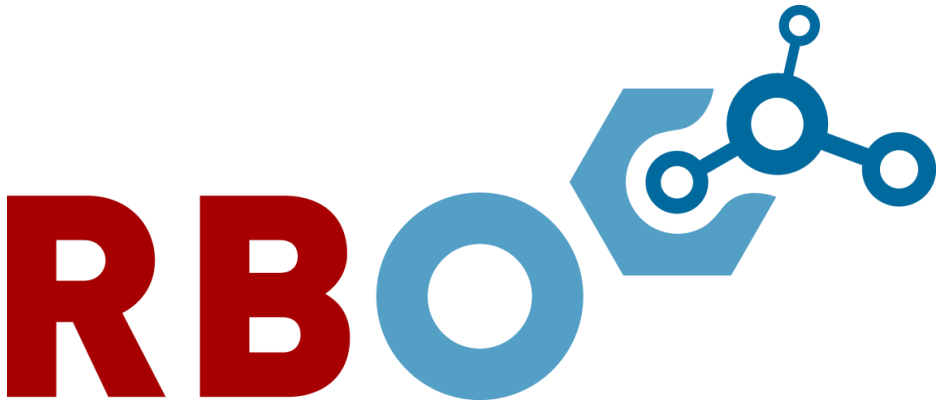
DI TECNOLOGIA

What can a simple hand do?

Antonio Bicchi
with
M. G. Catalano A. Ajoudani S.B. Godfrey M. Bianchi G.Grioli
A. Serio E. Farnioli C. Piazza M. Bonilla M. Garabini M. Gabiccini
thanks to
M. Santello (ASU), D. Prattichizzo (UNISI), N. Tsagarakis (IIT)

softhands

THE Hand Embodied



Soft Manipulation with Environmental Constraints

Oliver Brock, Raphael Deimel, Clemens Eppner,
José Alvarez Ruiz, Marianne Maertens
Robotics and Biology Laboratory

Alexander von Humboldt
Stiftung/Foundation

Technische Universität Berlin

Julia Child (1912 – 2004)

Thanks, Matt Mason!

A Scene From

The French Chef - Julia Child

The Potato Show

Season 1, Episde 22, 1963

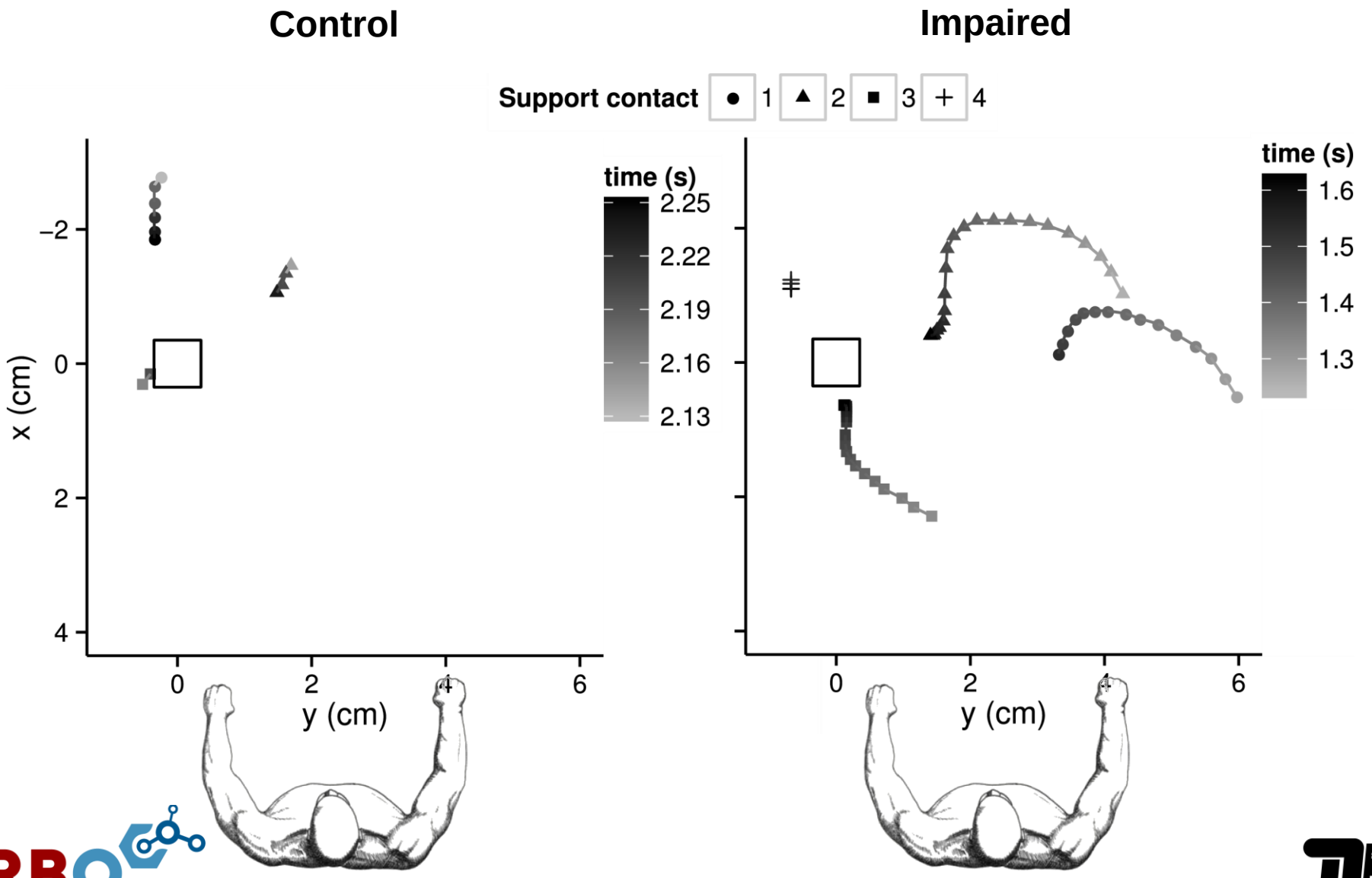
Human Grasping Strategies

Two Experimental Conditions

Control

Impaired

Traces of Support Contacts



The Shape of Synergies

Glossary: "Postural Synergies"
= Principal Components
of Grasp Covariance Matrix

First two synergies explain ~84%,
first three ~90% of the covariance.

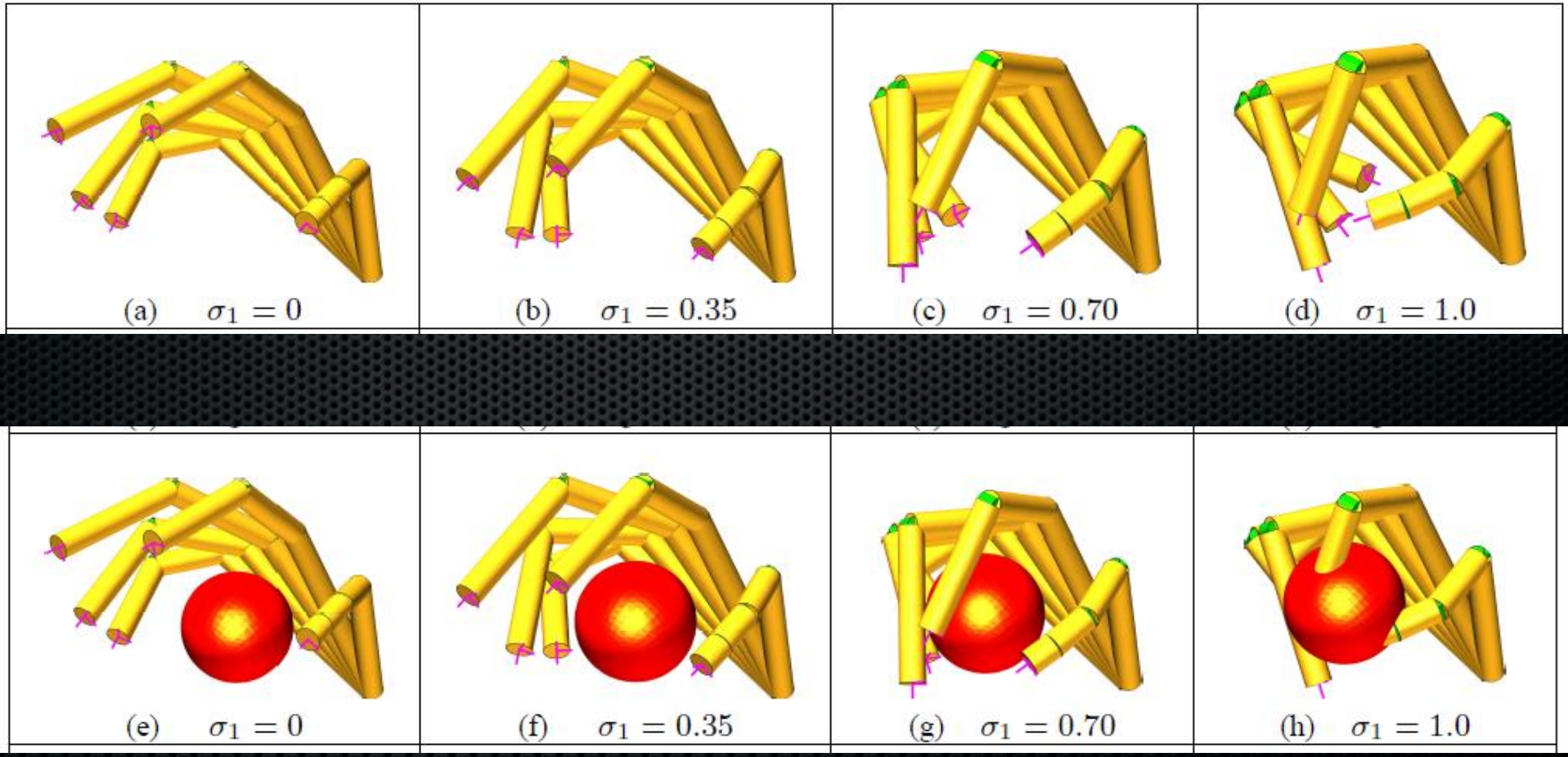
First synergy alone more than 50%

$$S = \begin{bmatrix} \vdots & \vdots & \vdots & \vdots & \vdots \\ S_1 & S_2 & S_3 & \cdots & S_n \\ \vdots & \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

(1-st synergy) (2-nd synergy) (3-rd synergy)

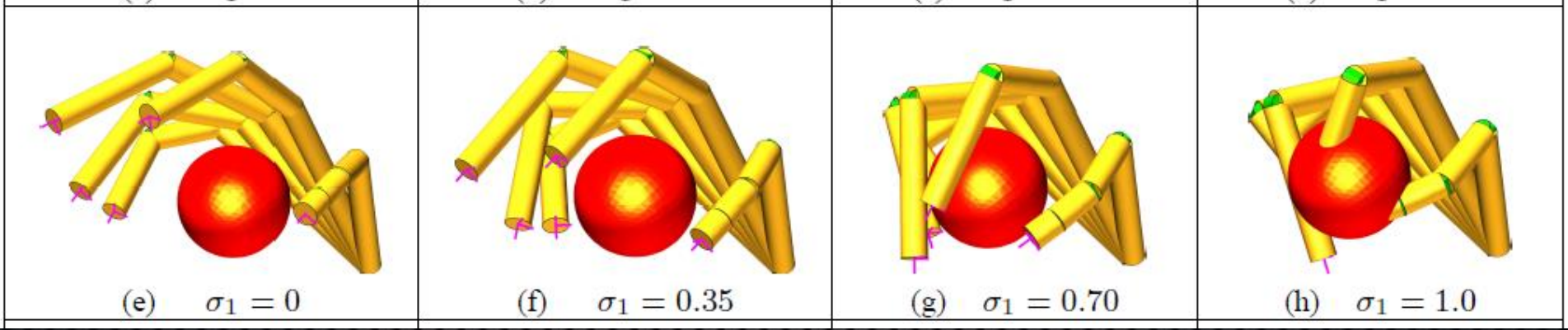
Geometric Synergies

Grasping a ball with one synergy would be impossible

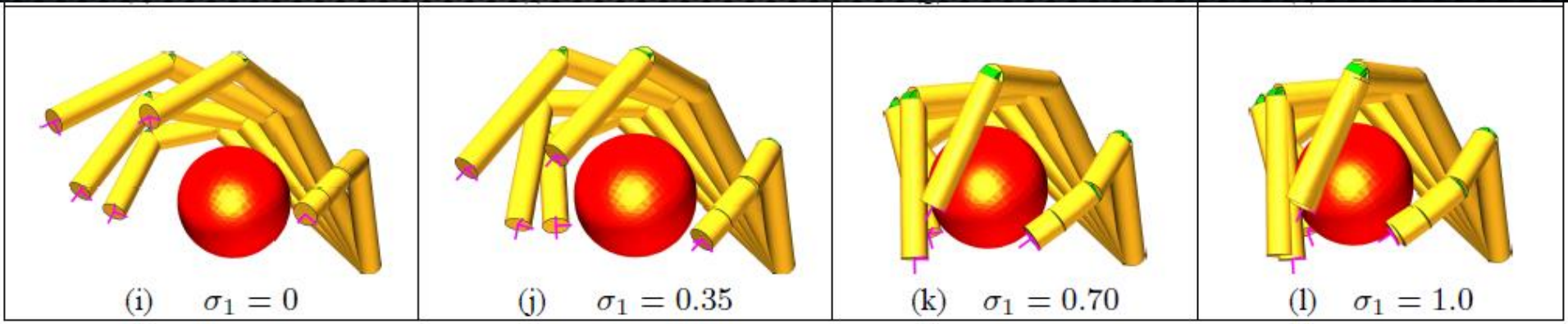


Soft Synergies (!)

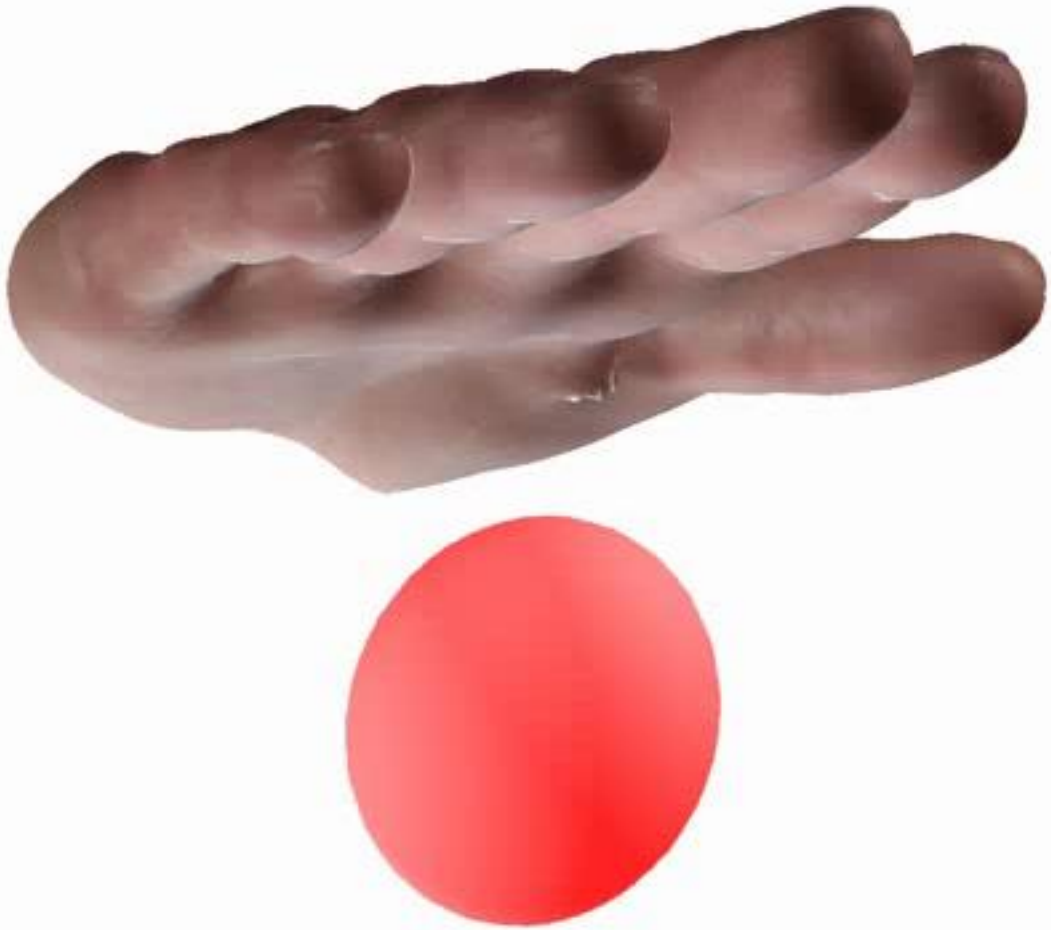
Geometric Synergies drive an “inner hand”



The real, compliant hand is attracted by the internal model and repelled by contact forces, reaching an equilibrium

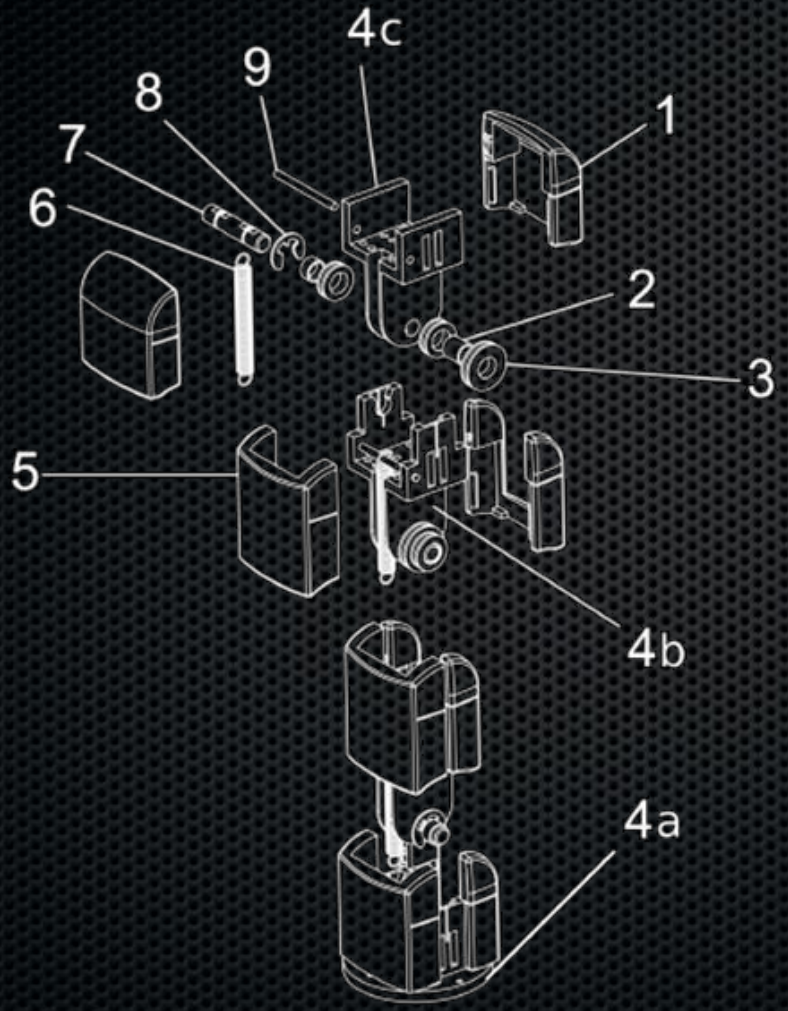


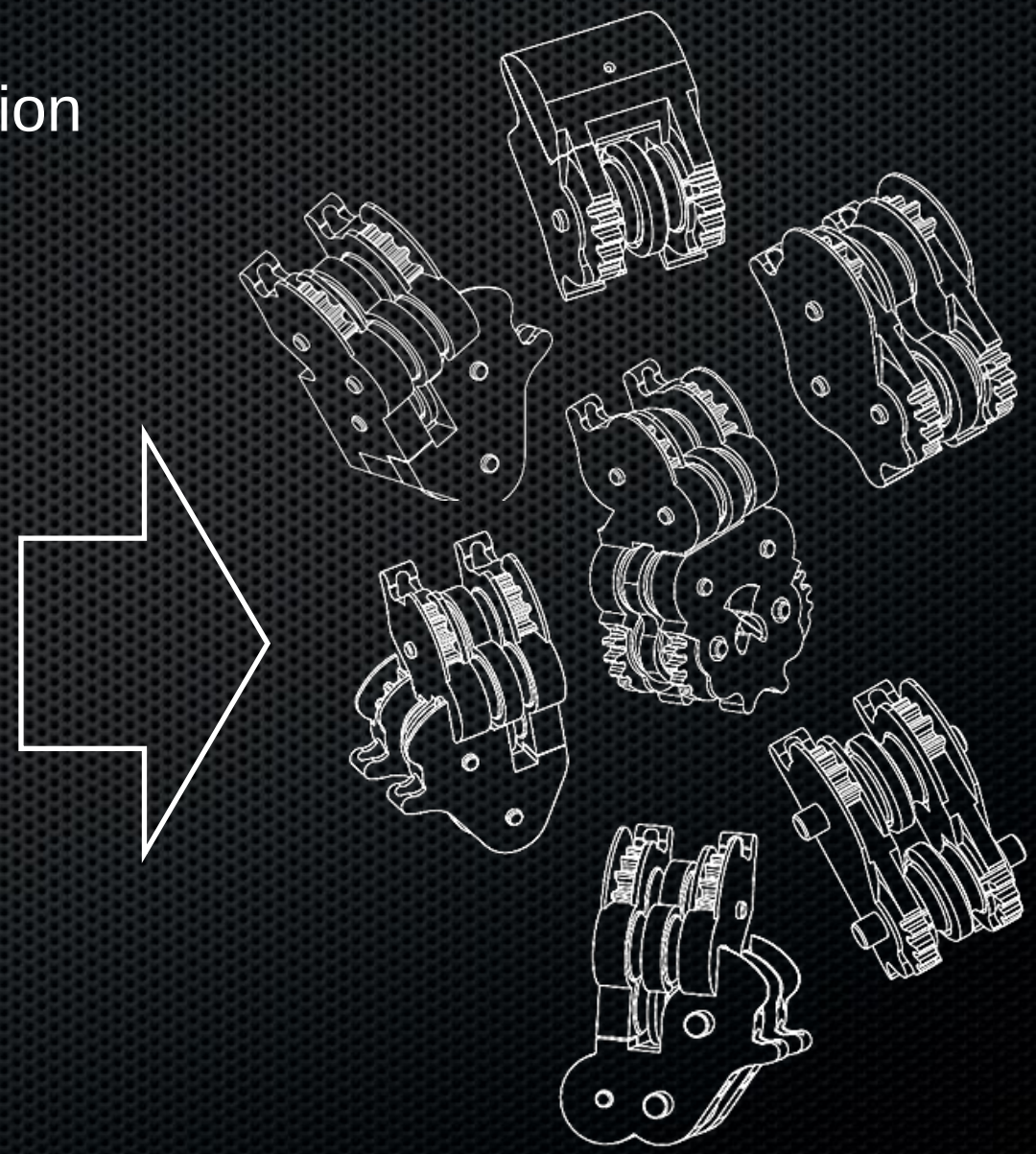
Small Red Object



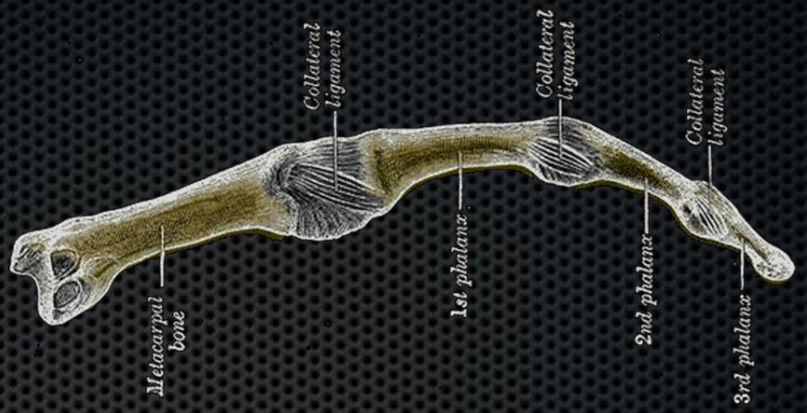
From theory to practice

Module design optimization

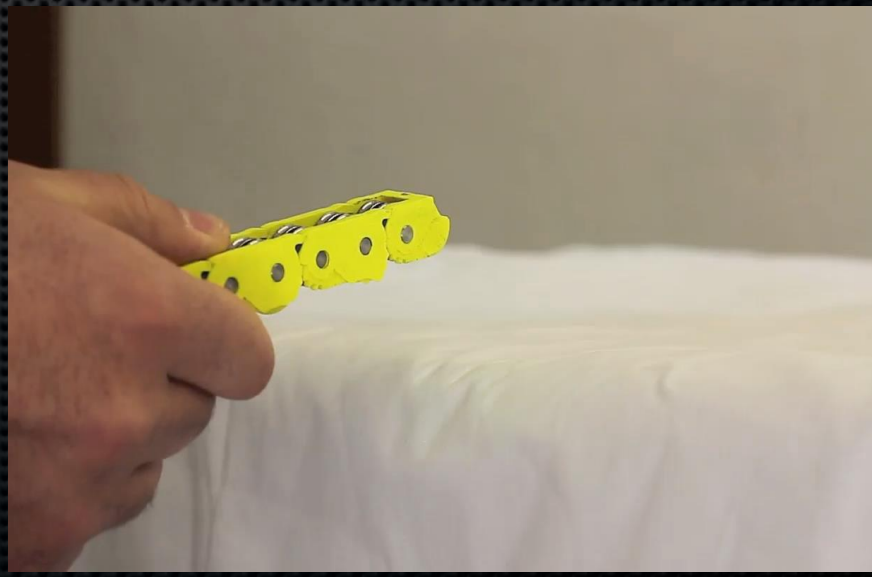




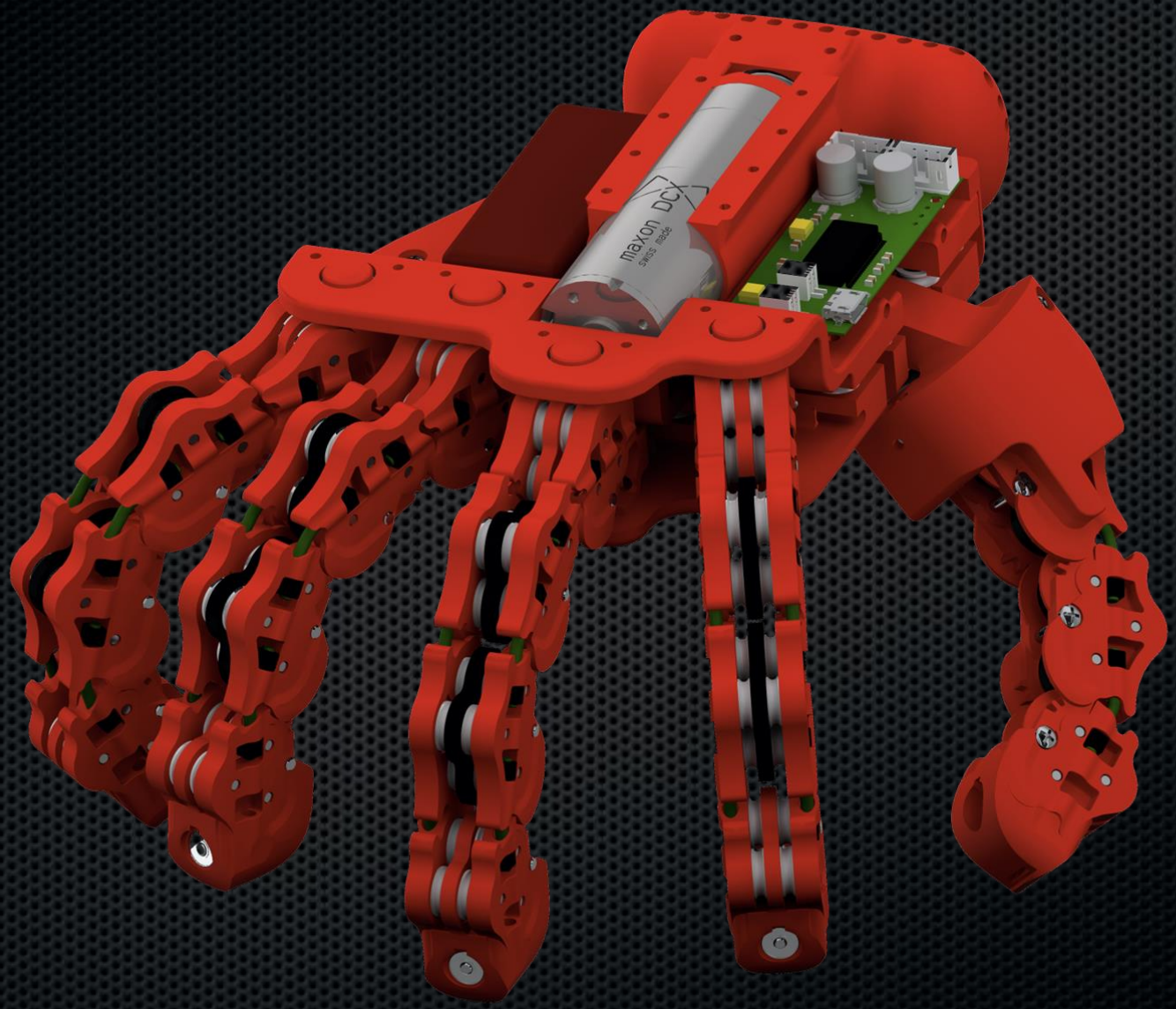
Innovative Design



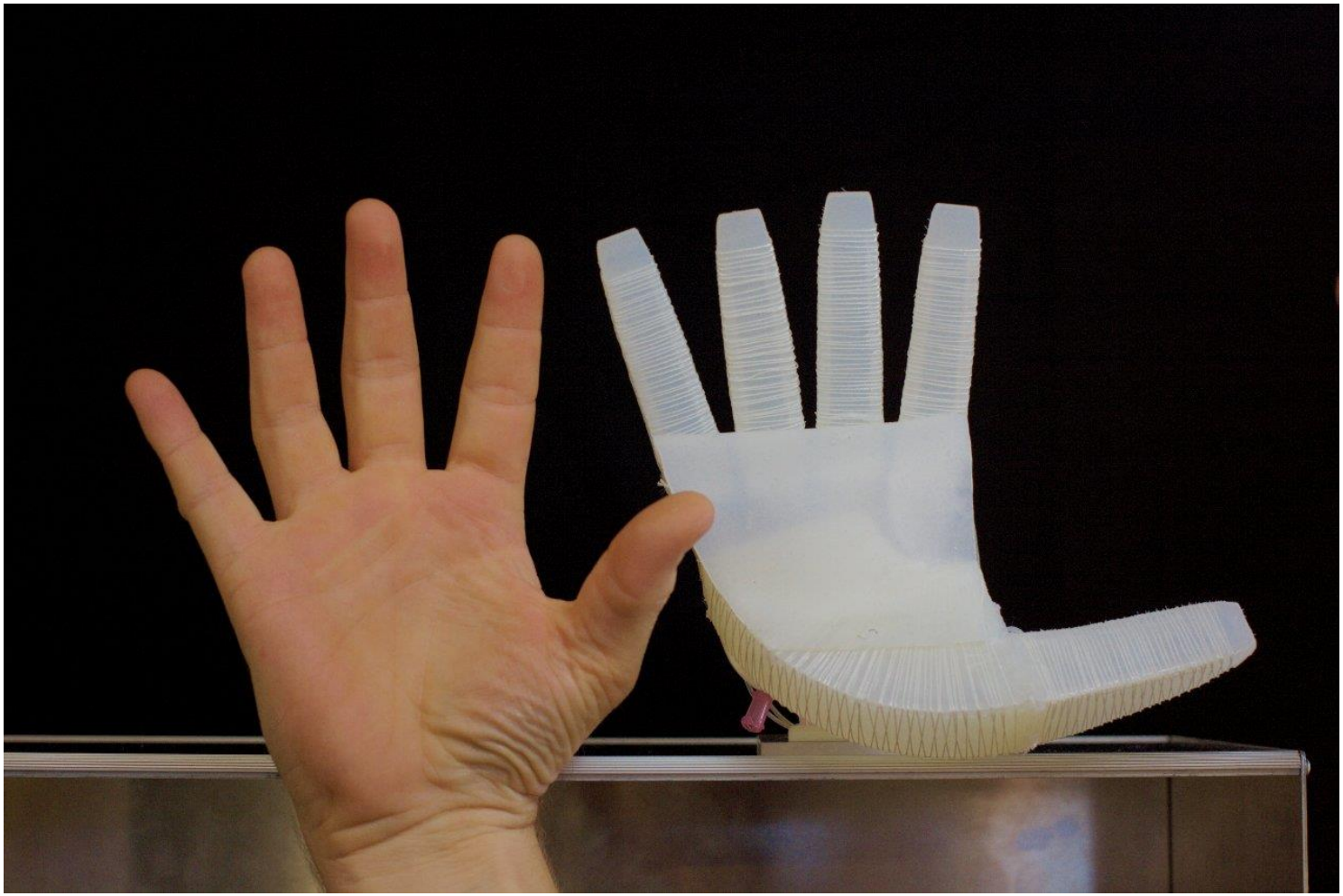
Articular Joints
and Soft Ligaments
for Robustness & Safety



The PISA/IIT Soft Hand

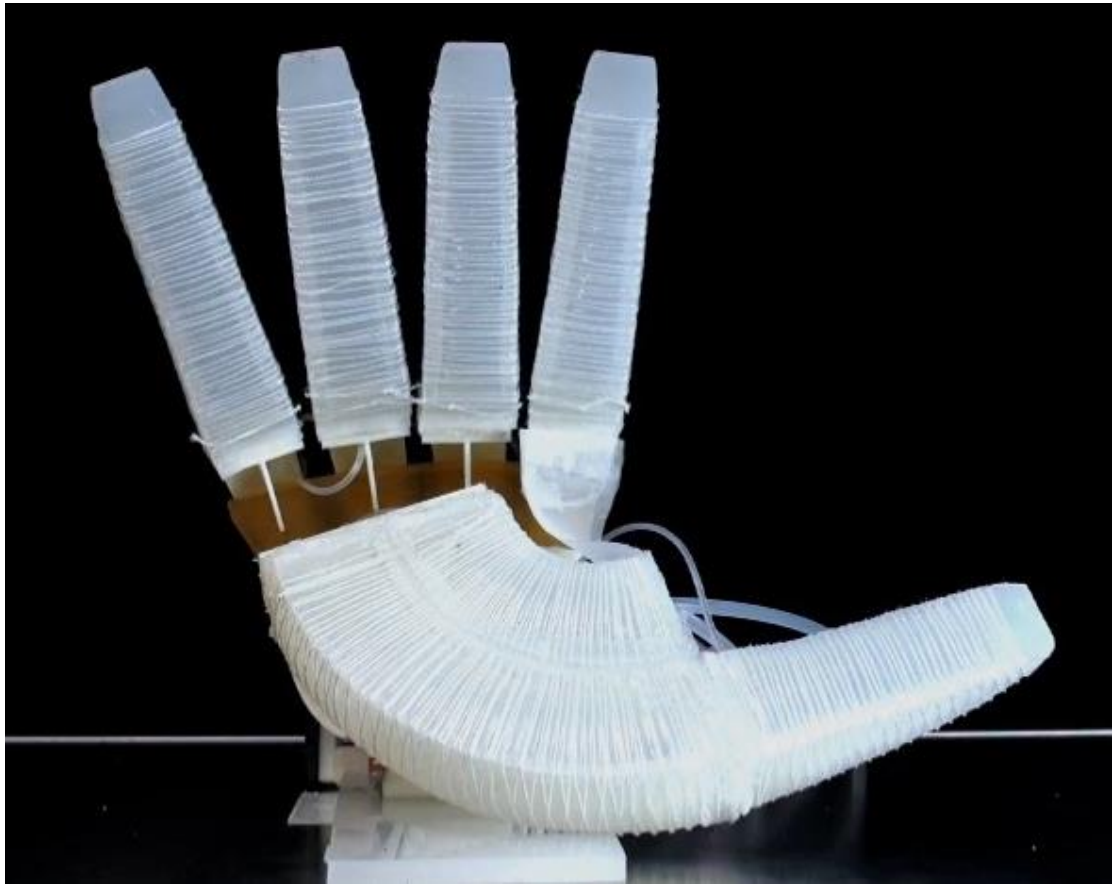


RBO Anthropomorphic Hand (Prototype I)



[Deimel & Brock, RSS 2014]

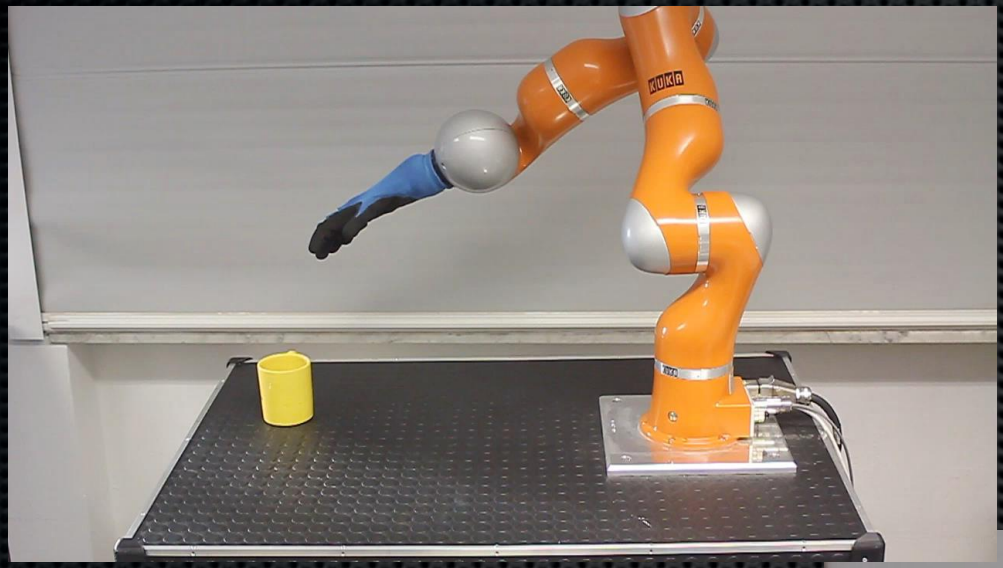
Finger = PneuFlex Actuator

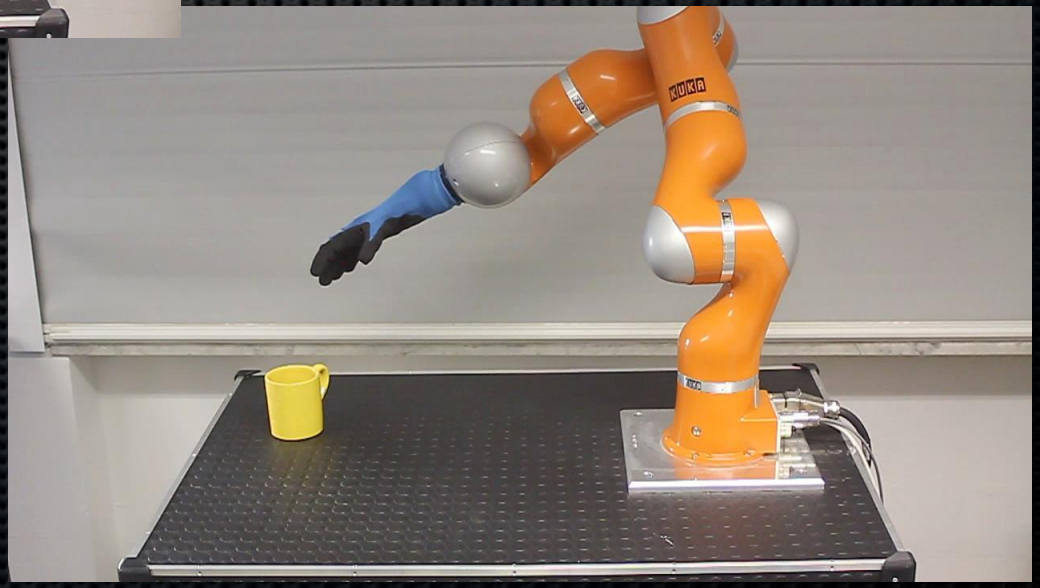


The Pisa-IIT Soft Hand

- 18 anthropomorphic joints
- One soft synergy
- One motor

Grasping mugs & embodied intelligence





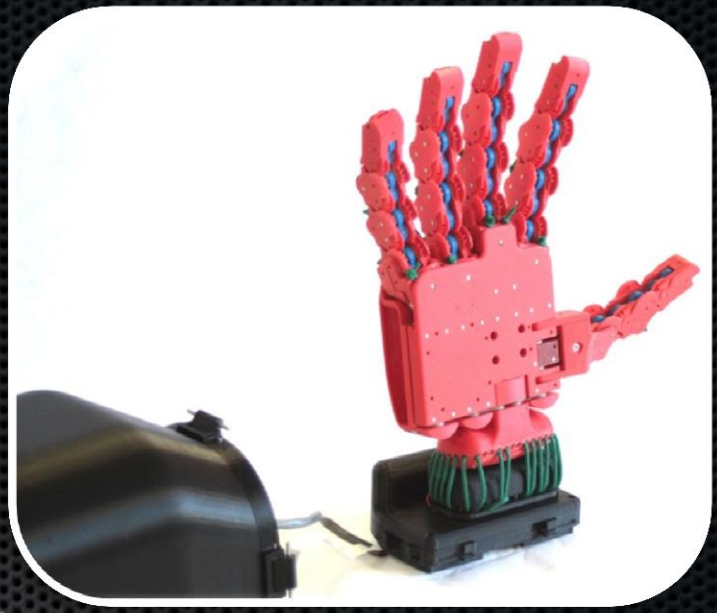
- Same hand
- Same object
- Same on/off control

- Two different grasps depending on affordance

Grebenstein's Robustness Test

What does human use of a robot hand teach us?

The Pisa-IIT SoftHand Human Interface



Humans can use the hand in a natural way

Wonders kids can do

look at this! →

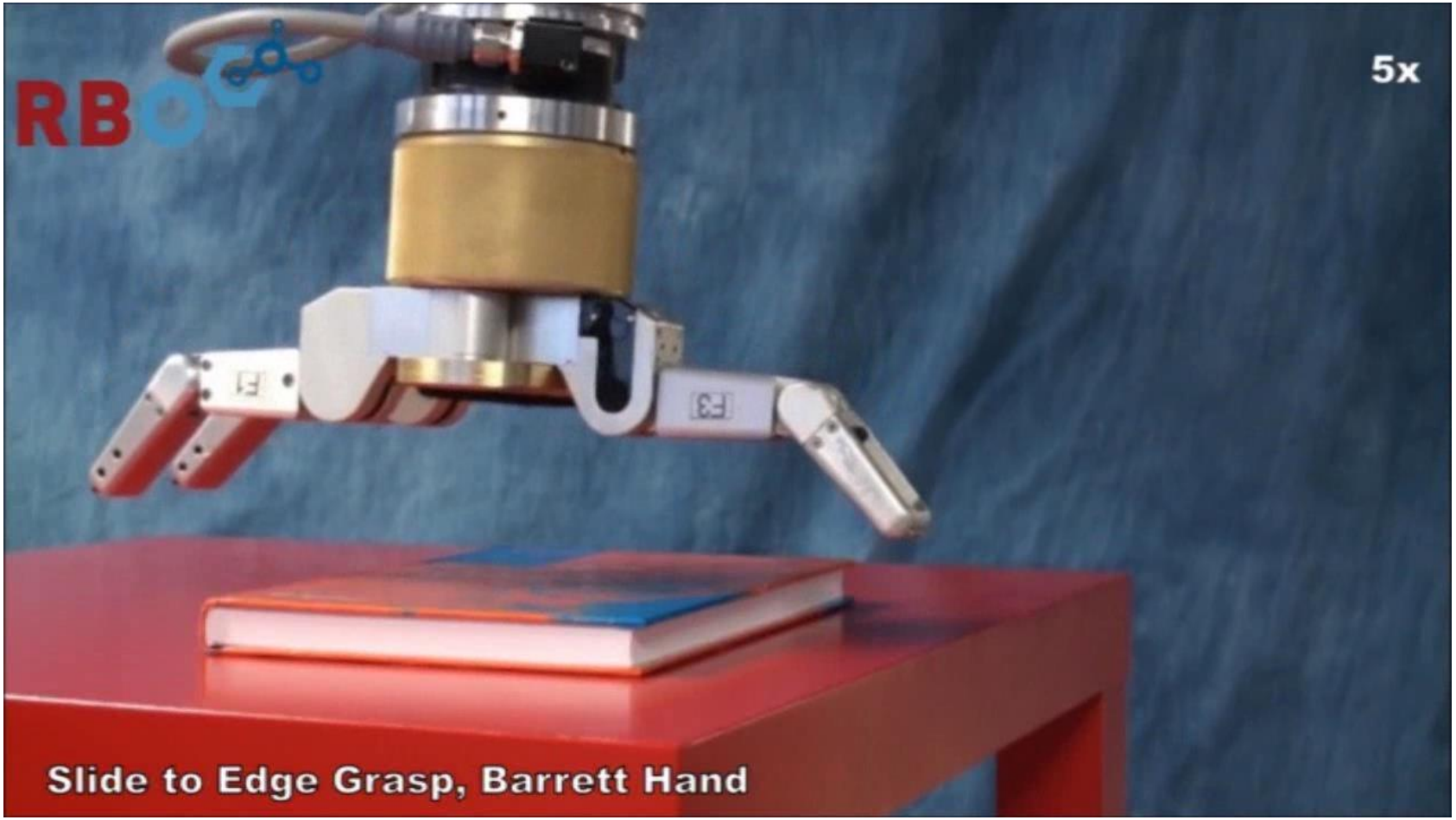
Inspired by the creative manipulation of kids, use the hand as if your own…

my preferred clip…

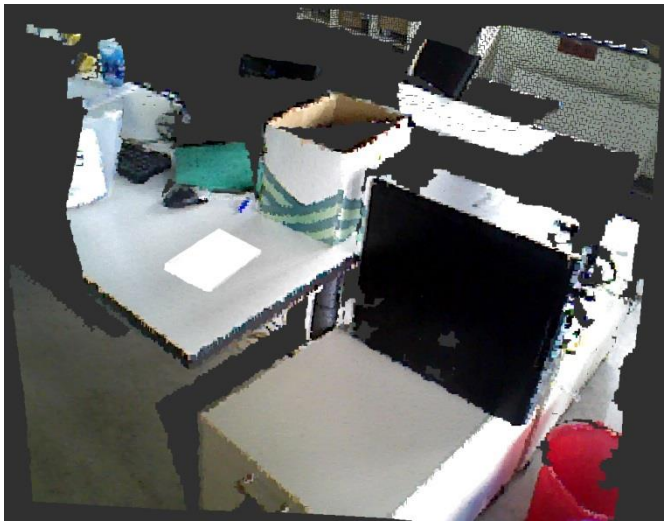
Questions

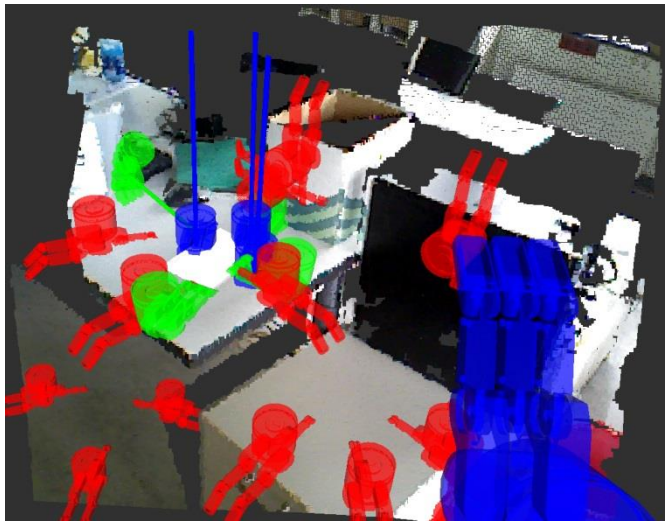
- Can we program a robot to use a soft, simple robot hand as effectively as humans?
- Using simple, soft hands changes grasp planning deeply:
  - thinking where to place fingertips for maximizing grasp measures might be less important
  - thinking on how to approach the environment to shape the hand properly for a grasp is more relevant
- Reasoning about robot-environment interaction is key!

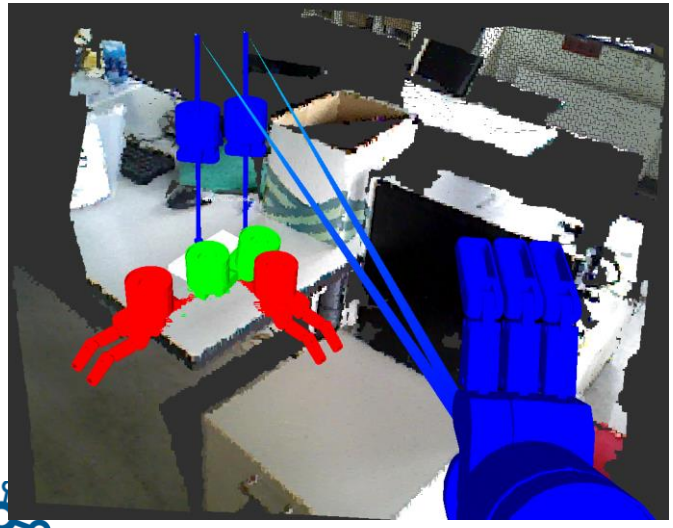
Grasping with Environmental Constraints

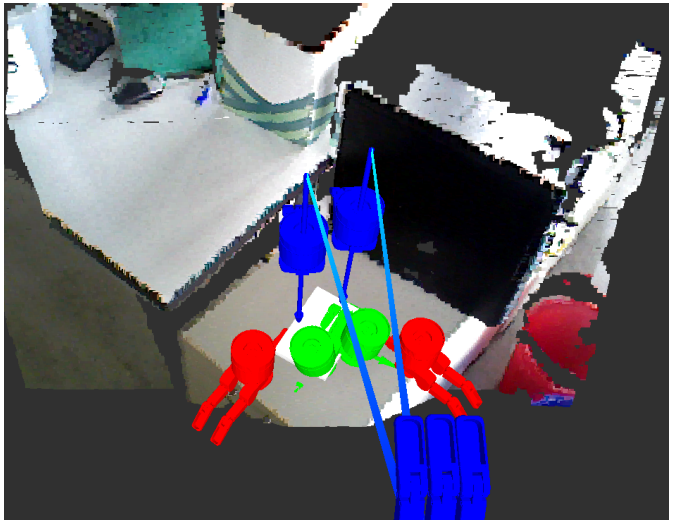


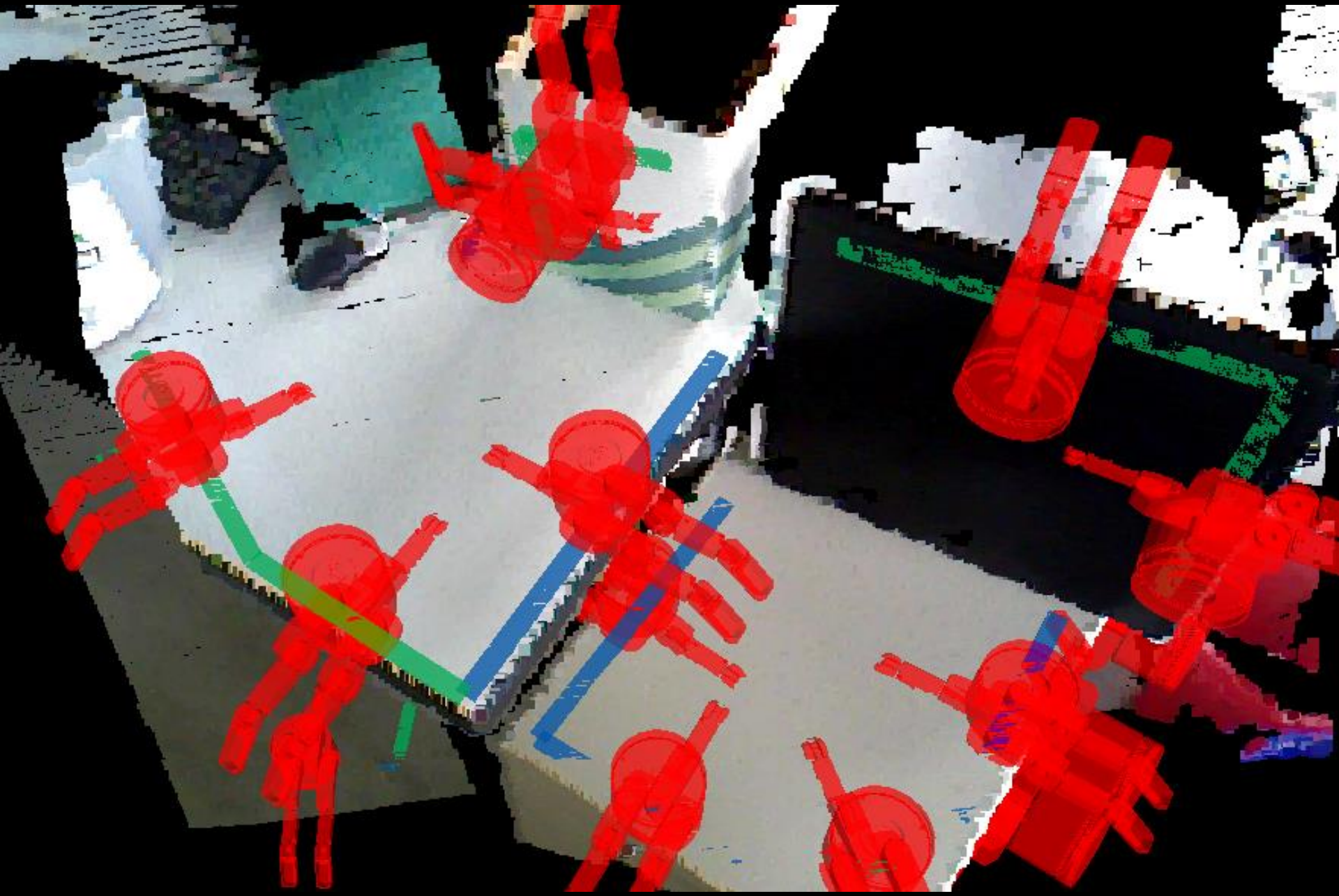
Perceiving/Planning Slide-to-Edge with Constraints

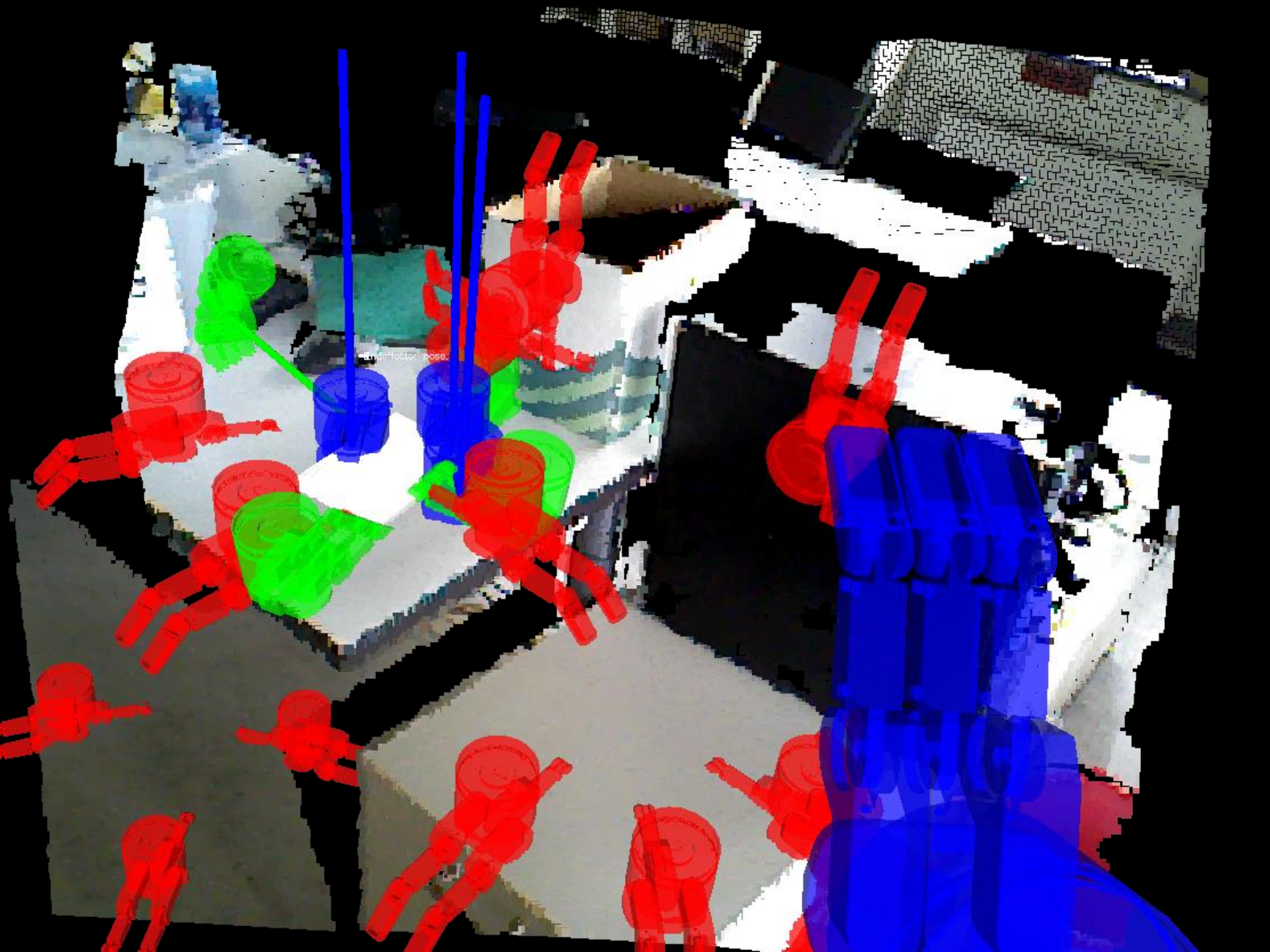


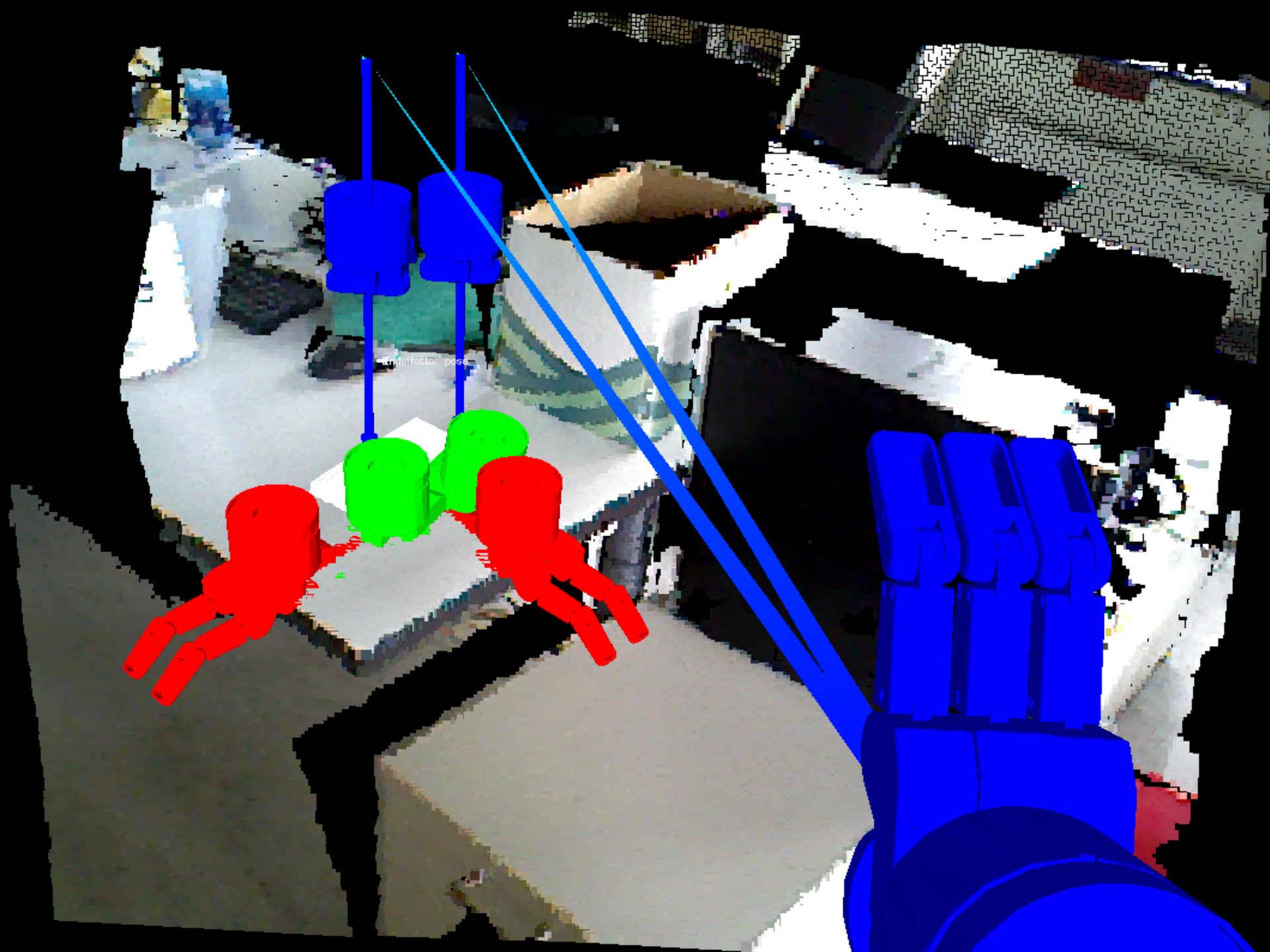


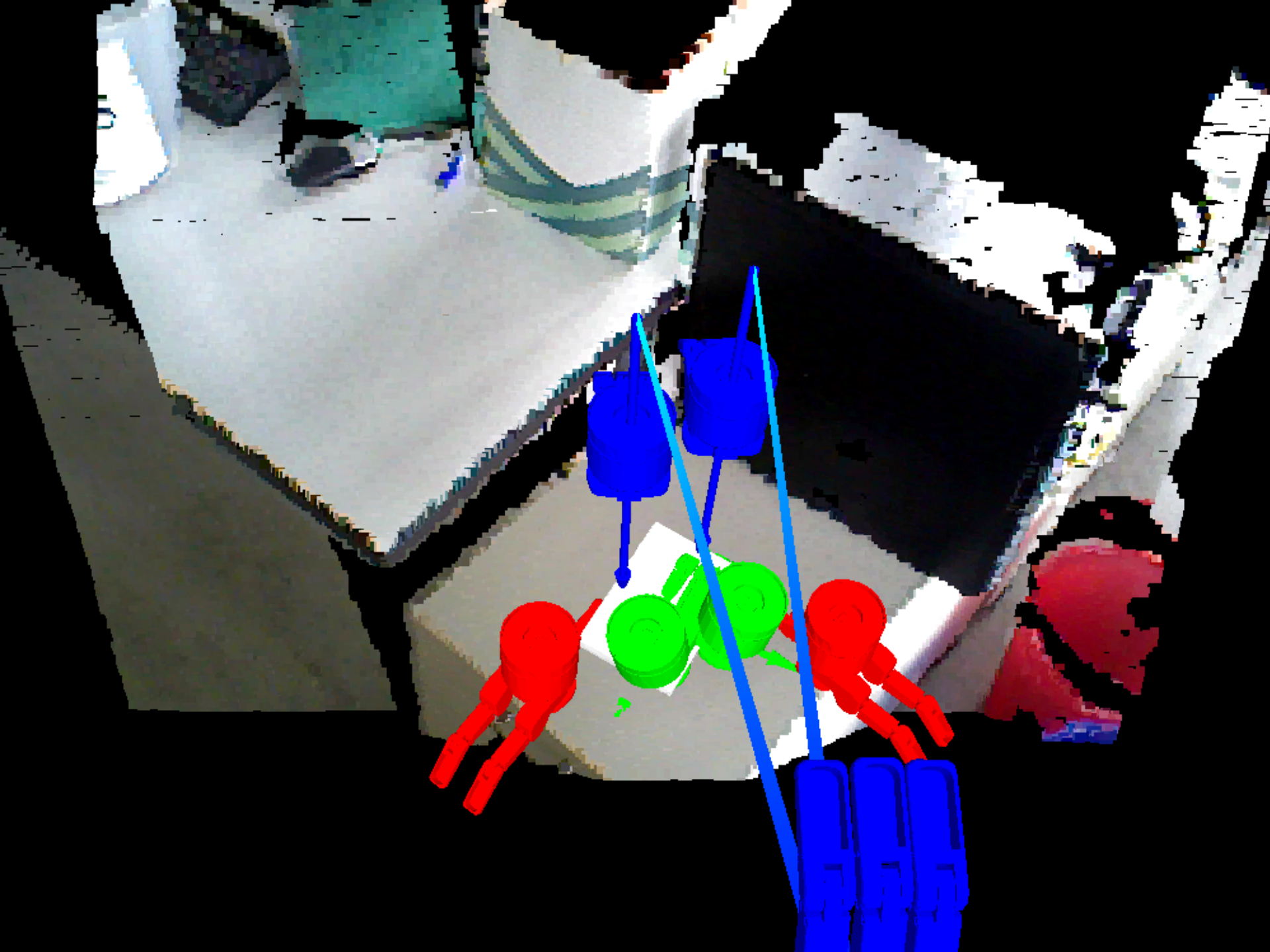







end effector pose.

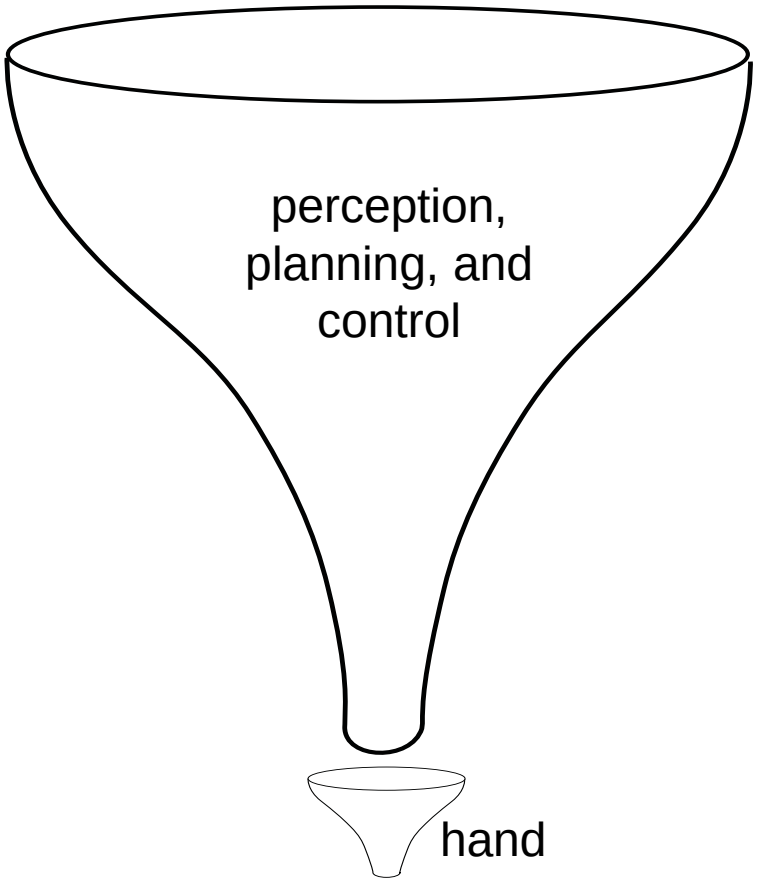




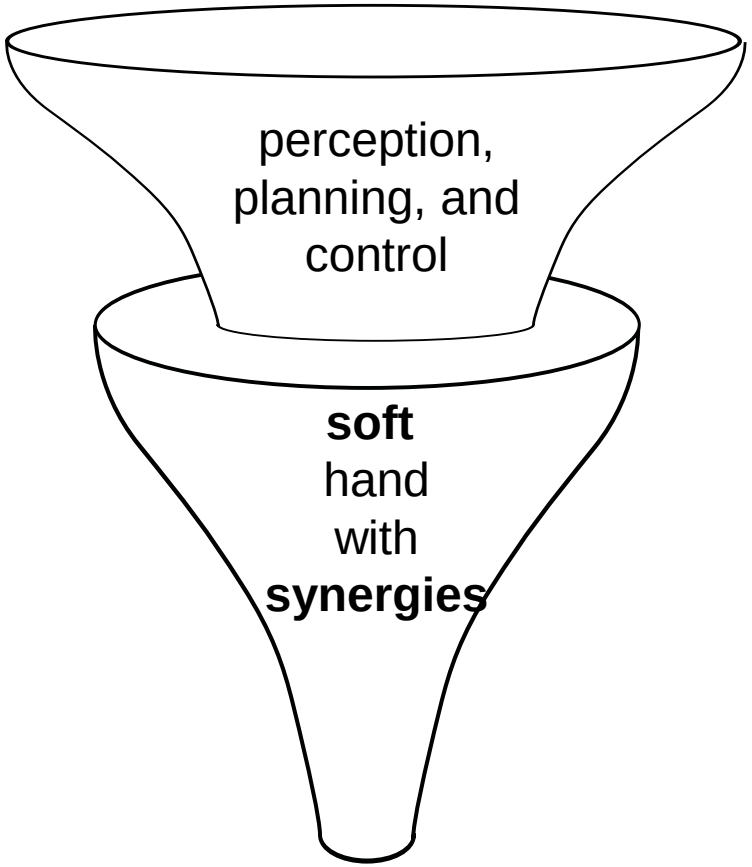
Bowl Grasp

Soft Grasping and Soft Manipulation

Little use of constraints = hard?

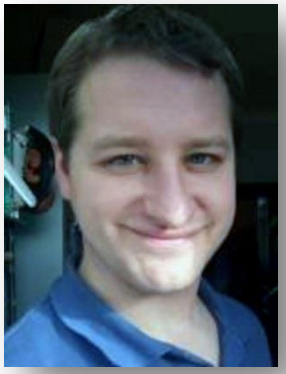


Extensive use of constraints = robust?



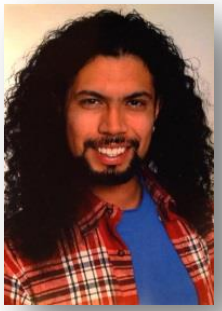
Thanks!

Marianne Maertens
Modelling of Cognitive Processes



Raphael Deimel

Clemens Eppner



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iit
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SEVENTH FRAMEWORK
PROGRAMME
erc
Thanks!