

MorphIO

Entirely Soft Sensing and Actuation Modules
for Programming Shape Changes through Tangible Interaction



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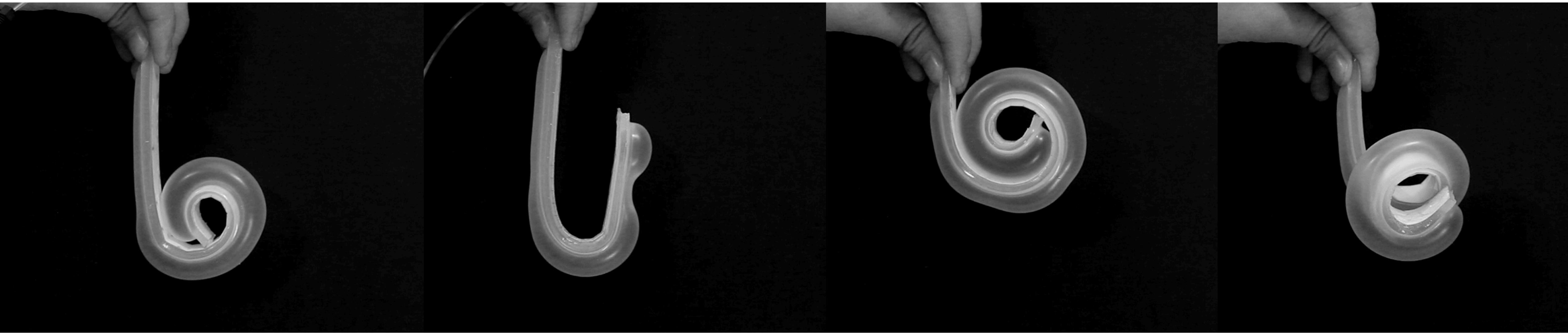
Keio University



University of Colorado
Boulder



THE UNIVERSITY
OF TOKYO

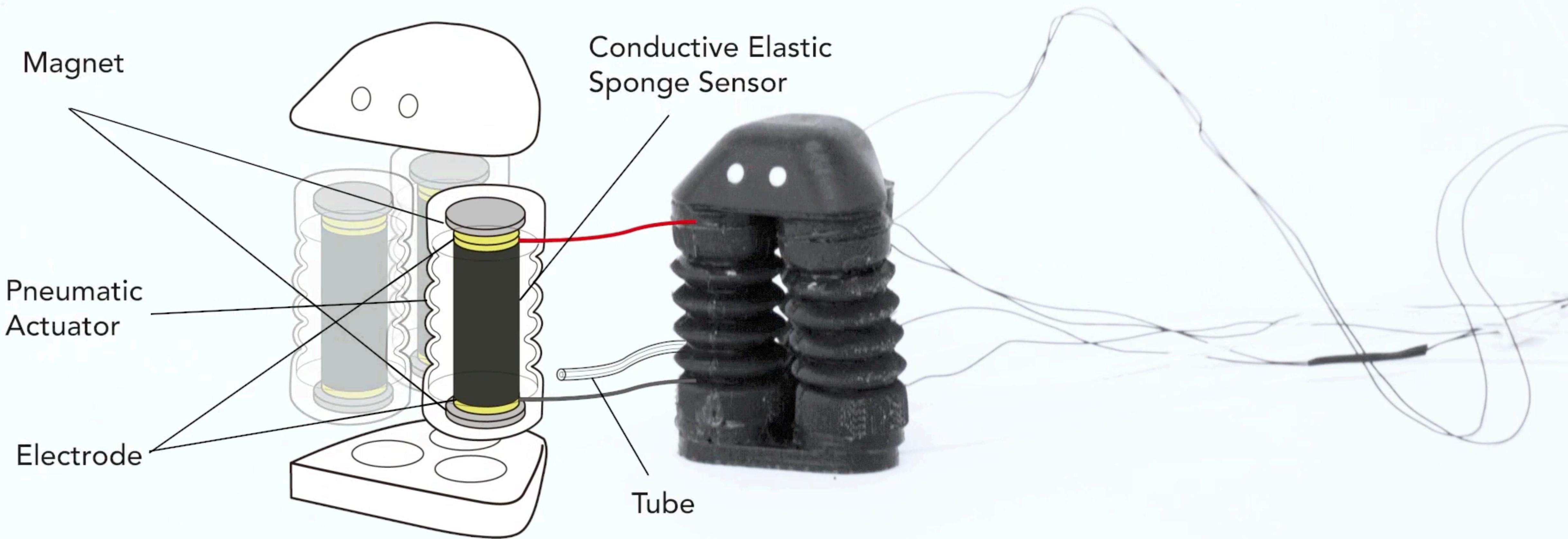


Programmable Soft Materials

Programming of

Soft Materials

is Hard



Contributions

1. **Entirely soft** sensing and actuation unit

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2. **MorphIO**, programming by demonstration environment

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1. **Entirely soft** sensing and actuation unit
2. **MorphIO**, programming by demonstration environment
3. **Applications** and user **evaluation**

1. Summary

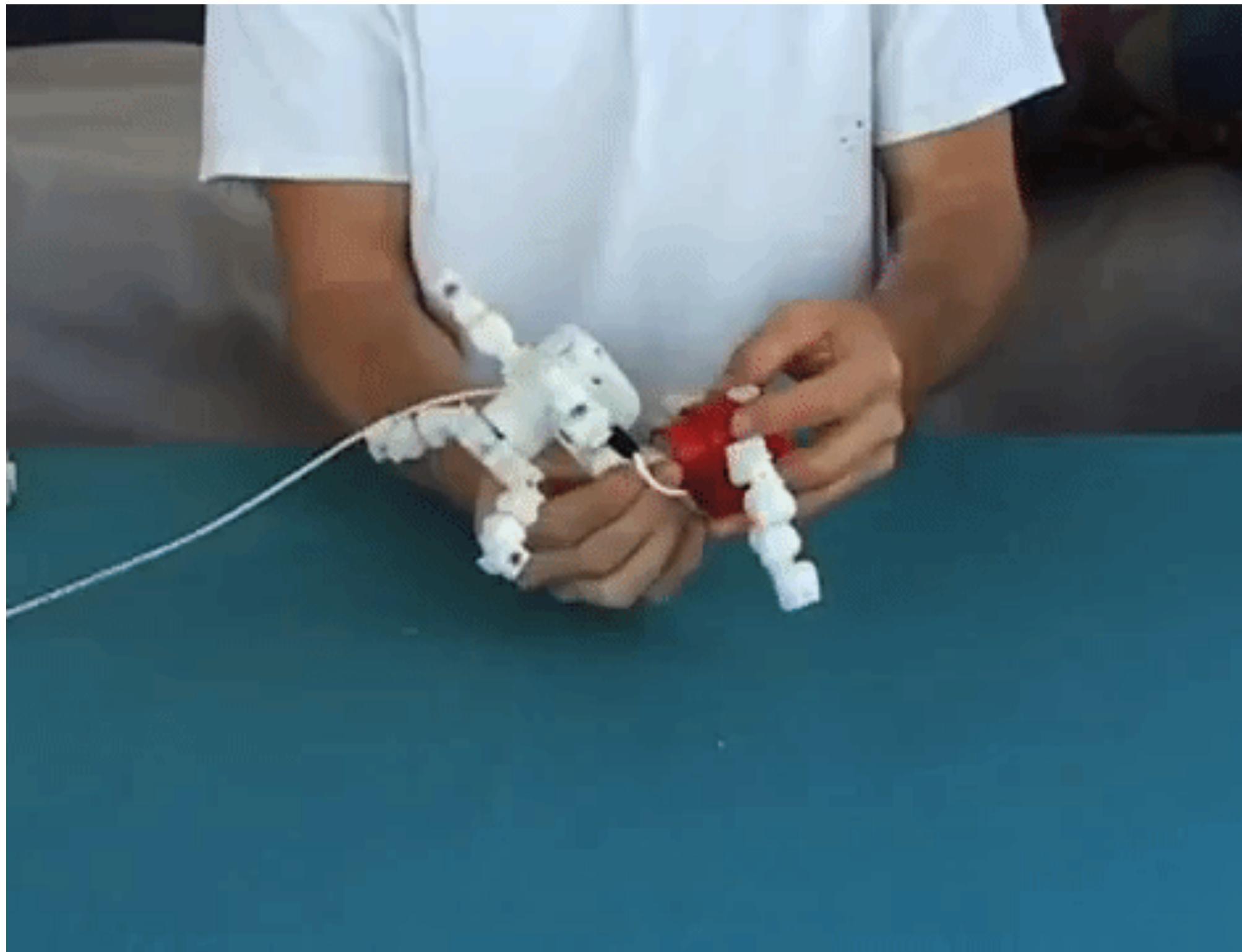
2. Related Work

3. MorphIO: System and Implementation

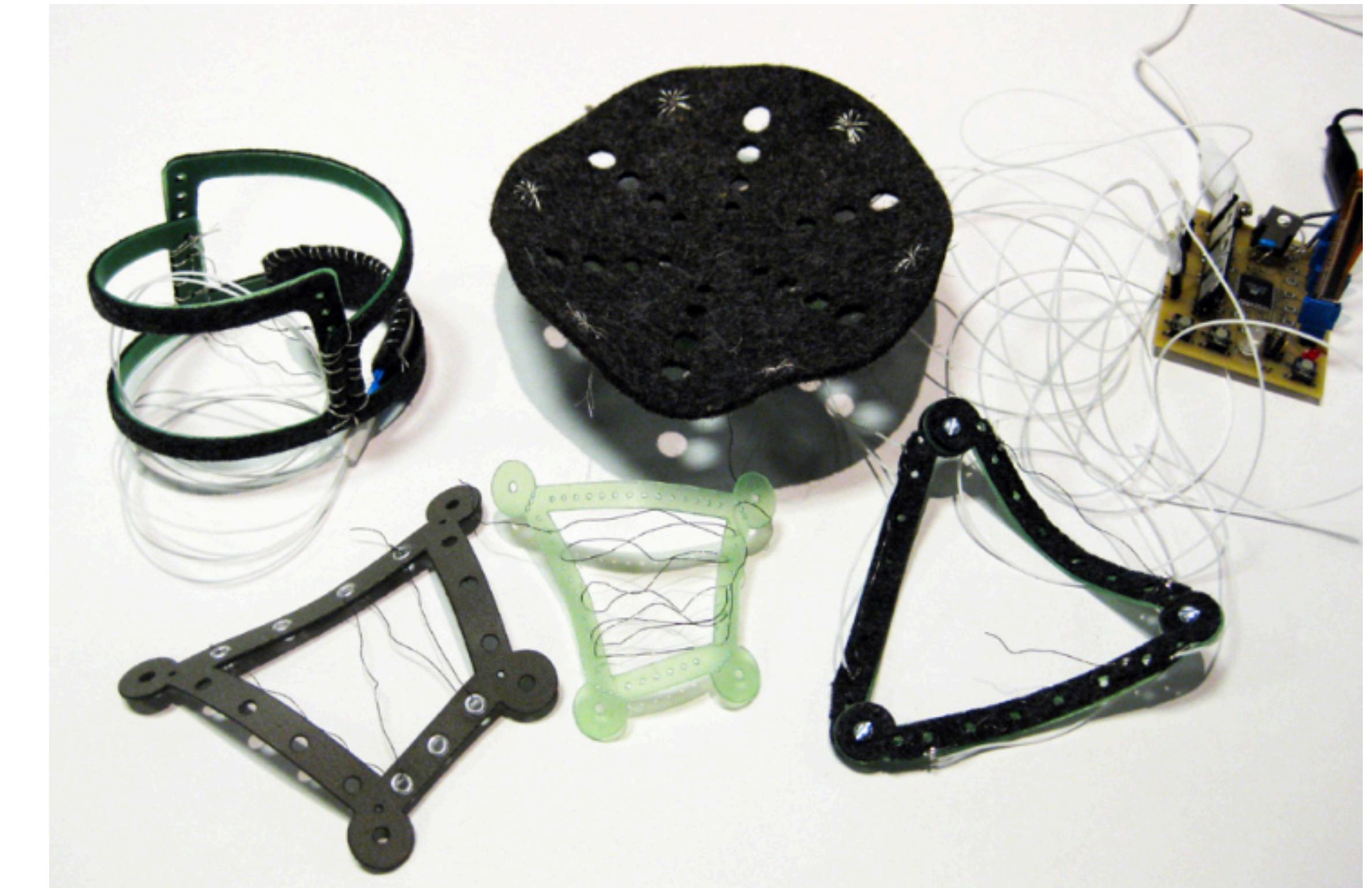
4. User Evaluation

5. Conclusion

Programming by Demonstration

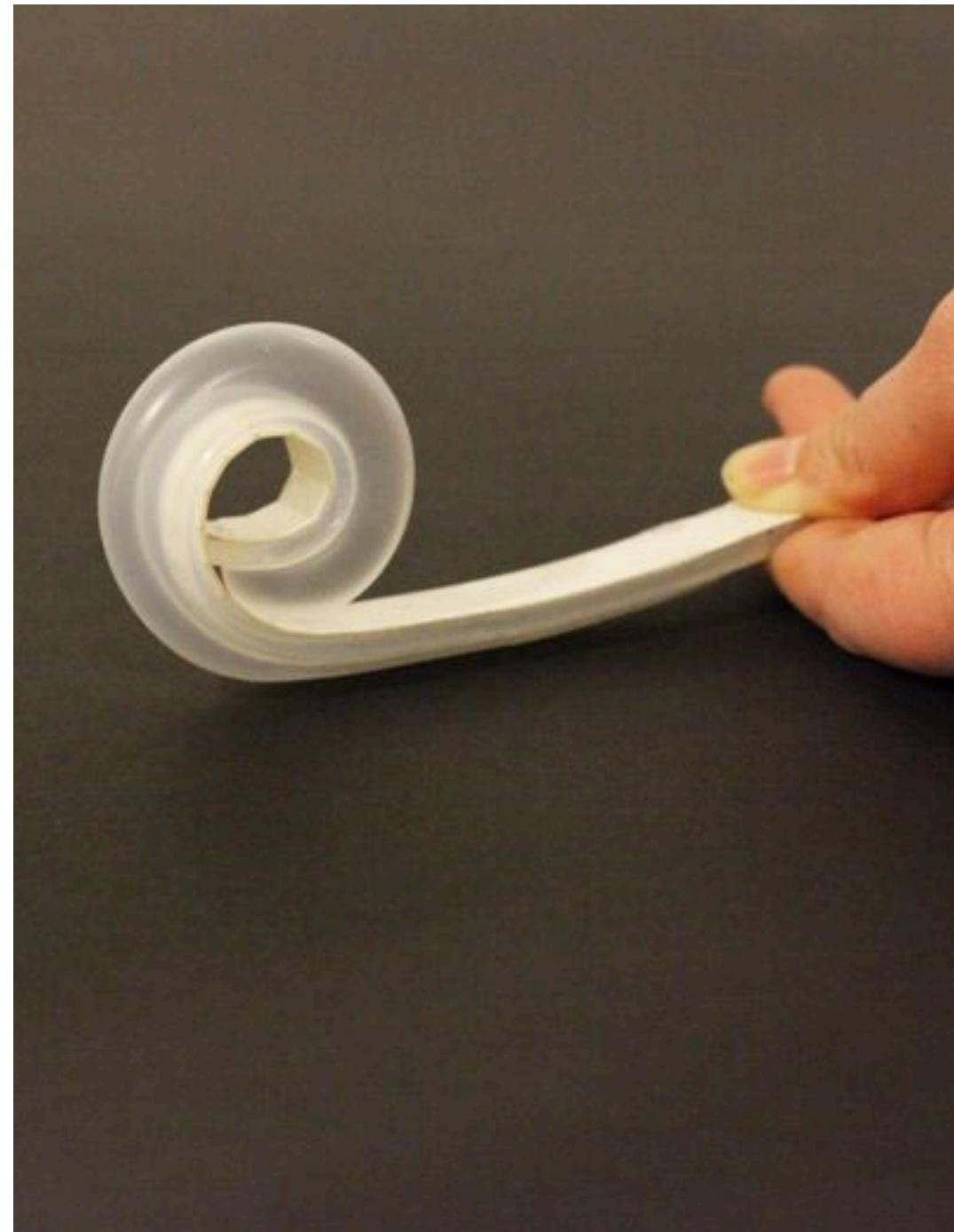


Topobo
[CHI 2004]



Bosu
[TEI 2010]

Shape-changing UI with Soft Materials



PneUI
[UIST 2013]



Jamming UI
[UIST 2012]

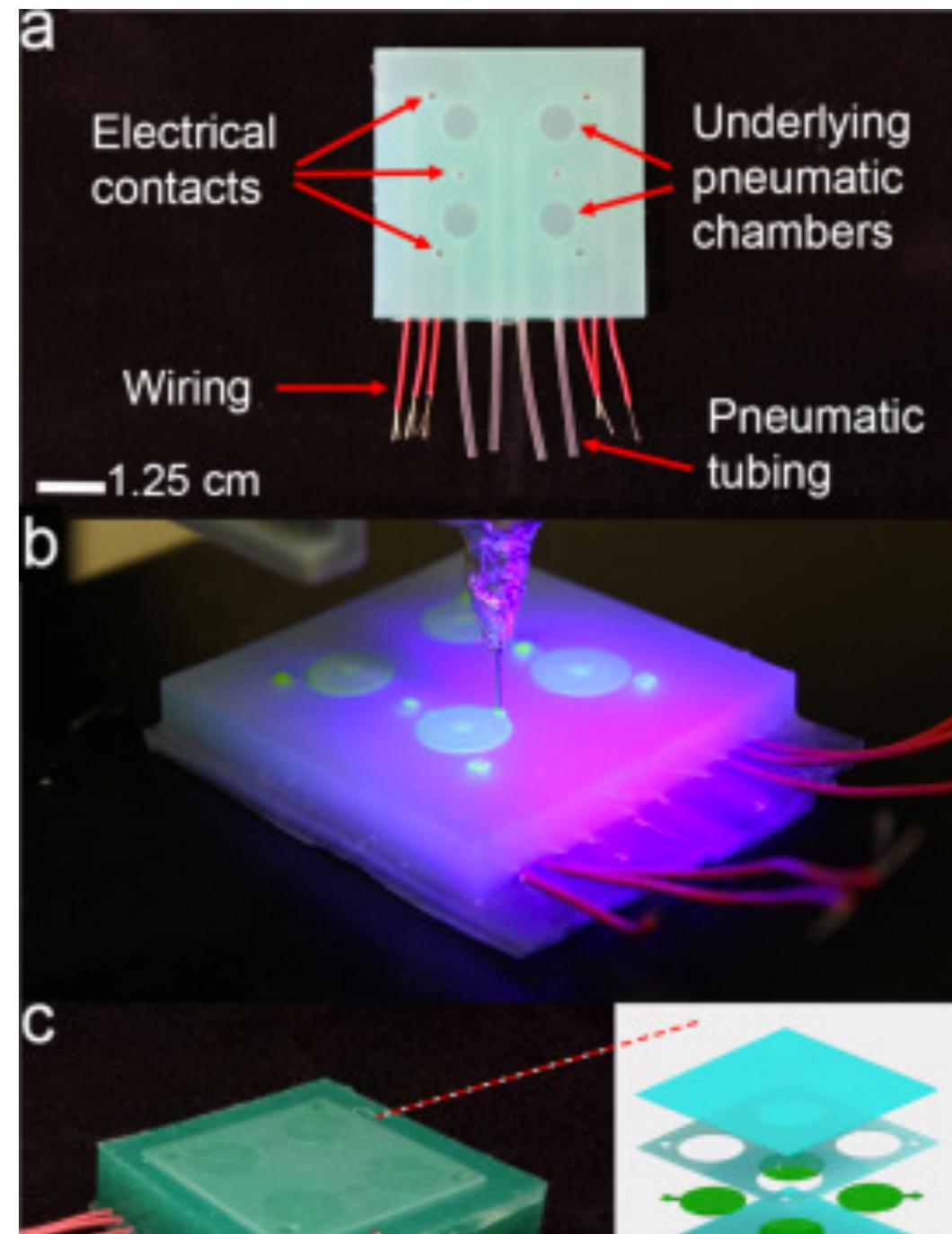


FoamSense
[UIST 2017]

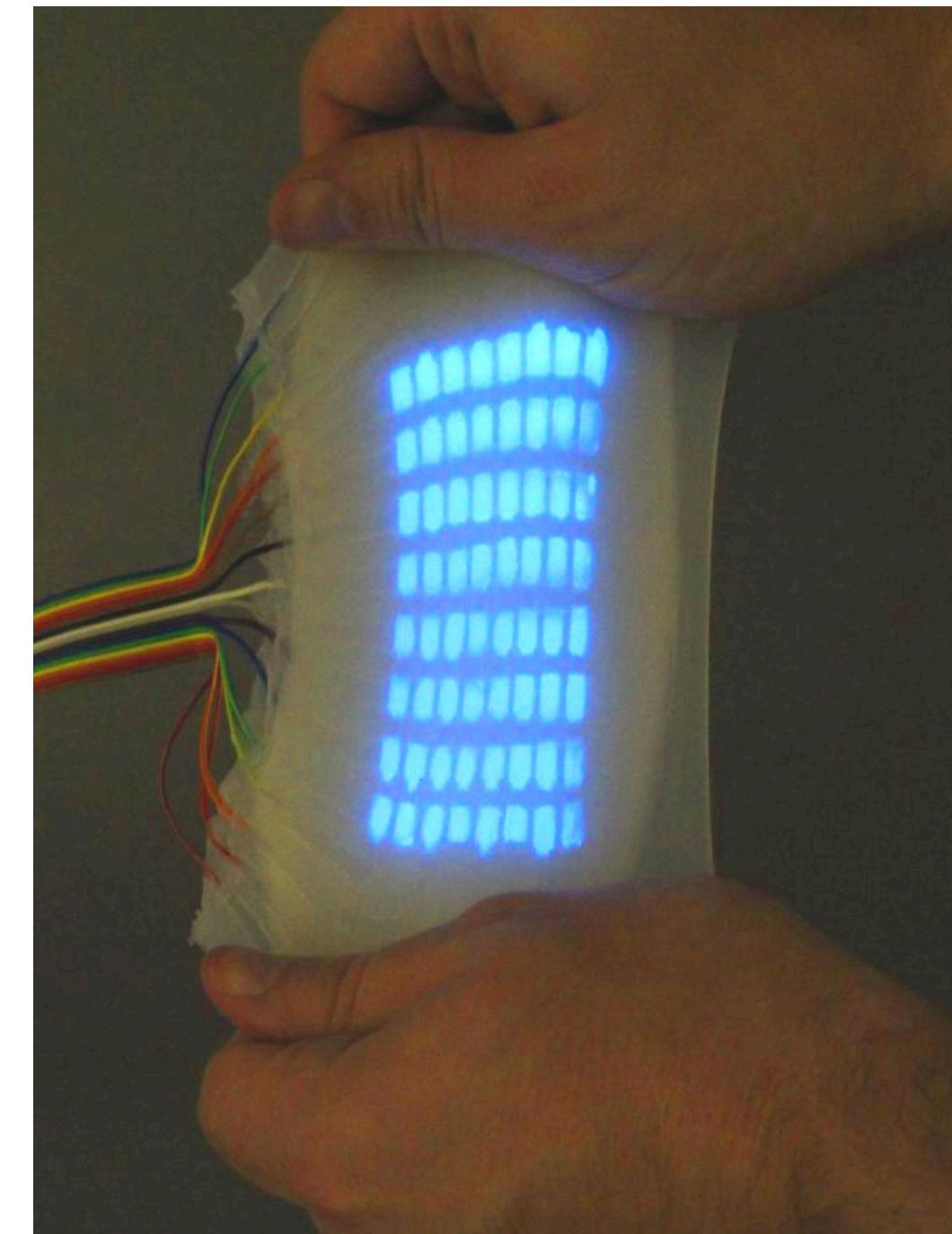


COLORISE
[TEI 2018]

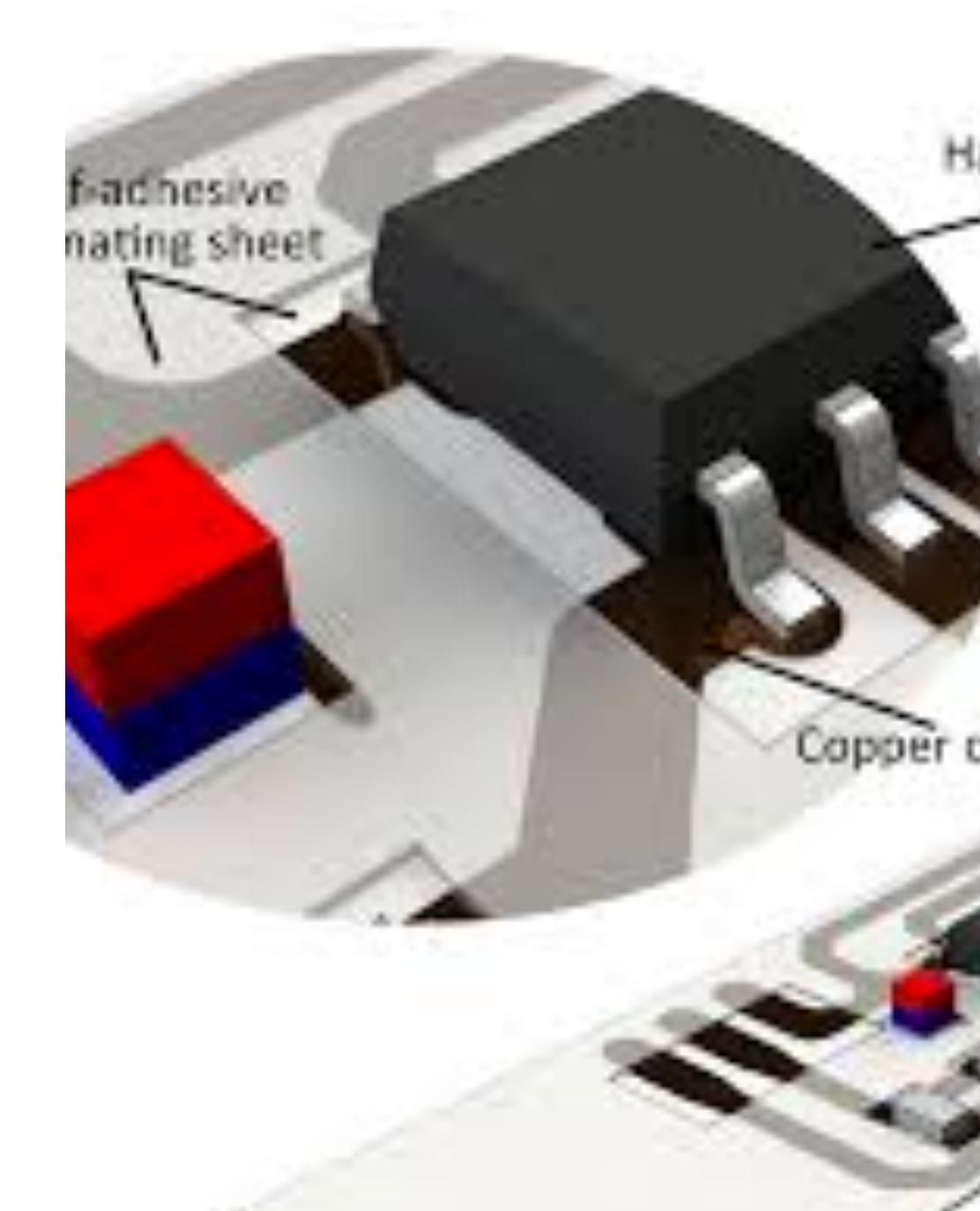
Integrated Soft Sensor + Actuator



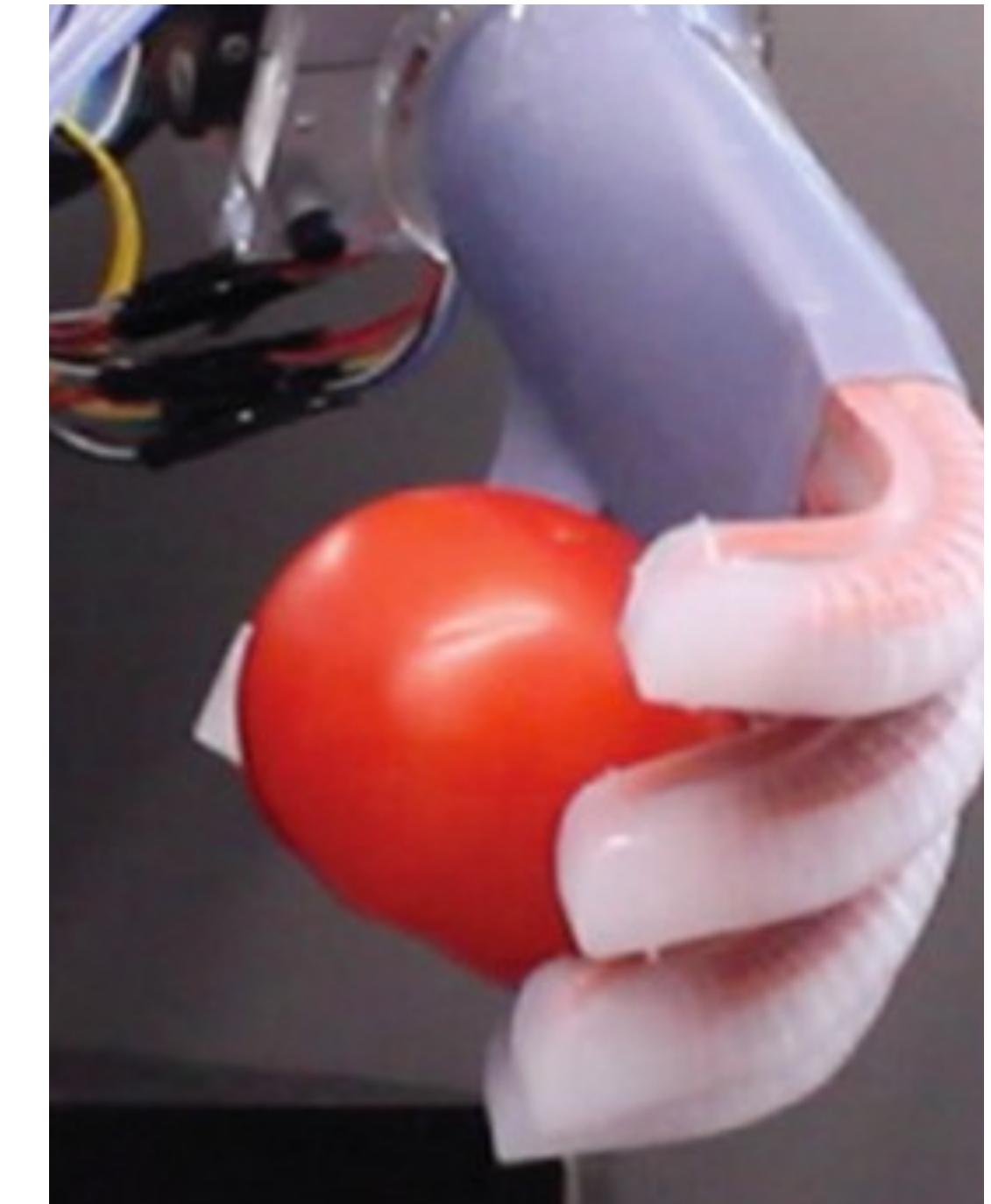
Direct Ink Writing
[EML 2015]



Capacitive
[Science 2016]



Magnetic
[ICRA 2016]



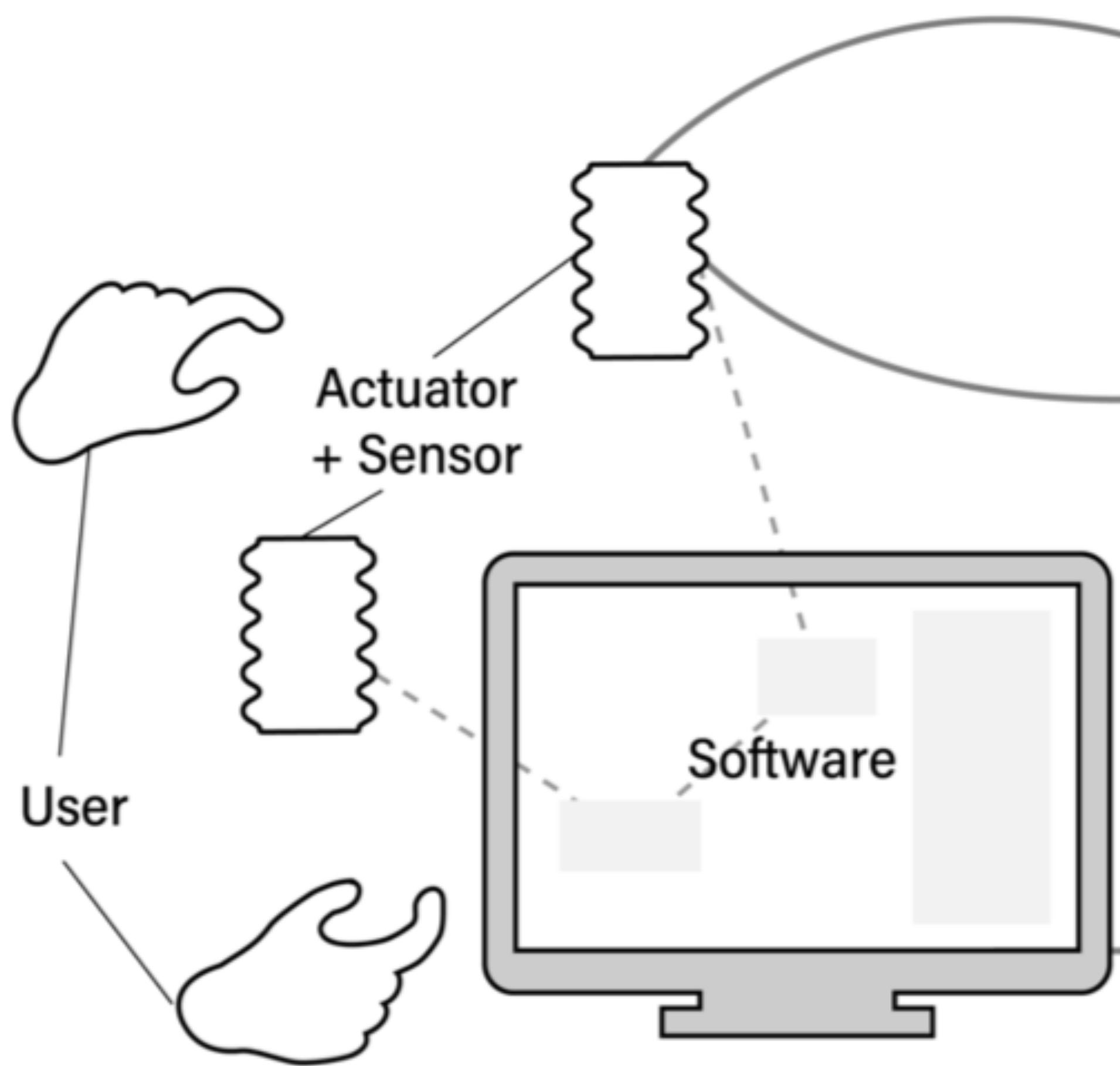
Optical
[Science 2016]

1. Summary
2. Related Work

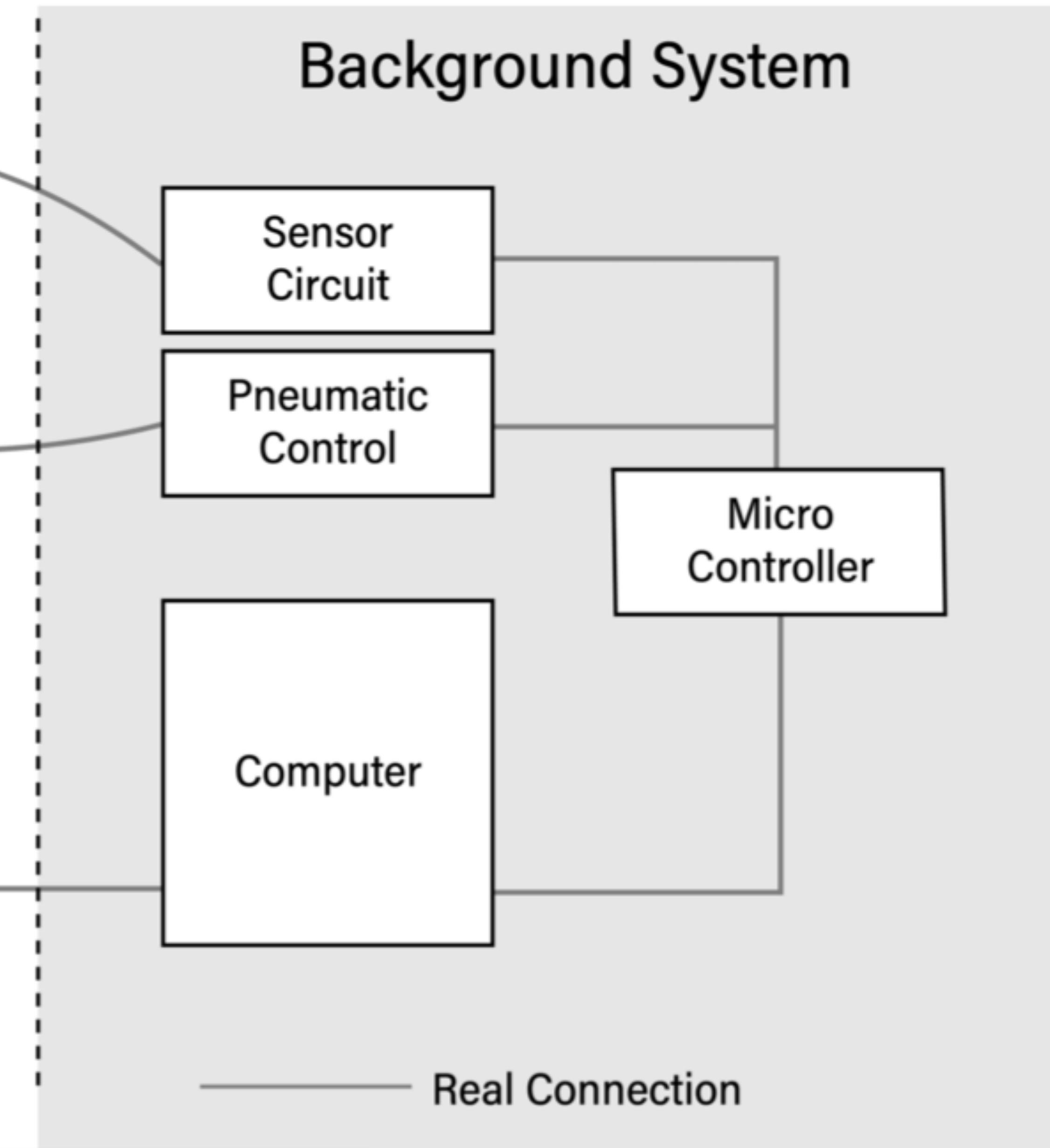
3. MorphIO

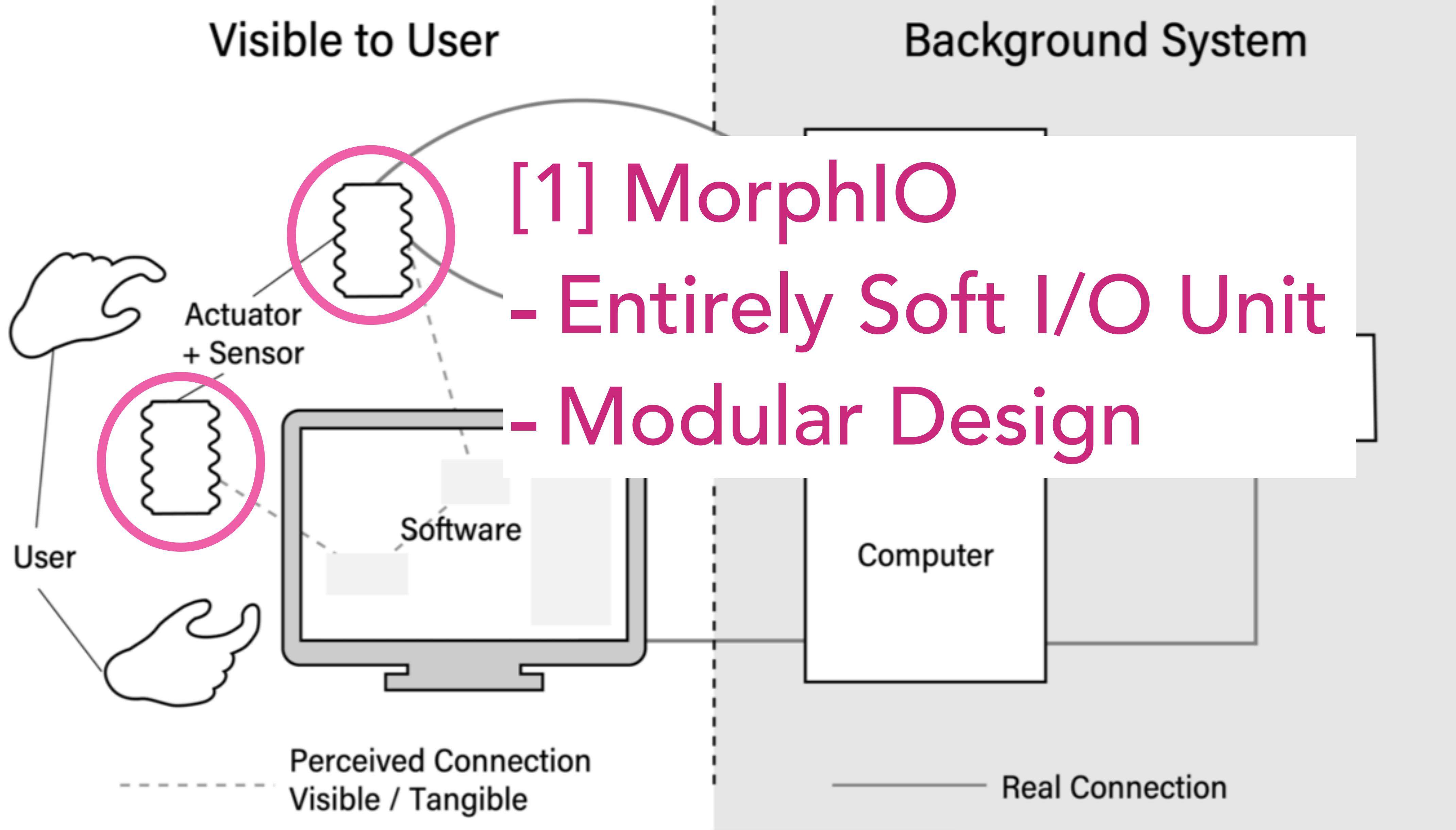
4. User Evaluation
5. Conclusion

Visible to User



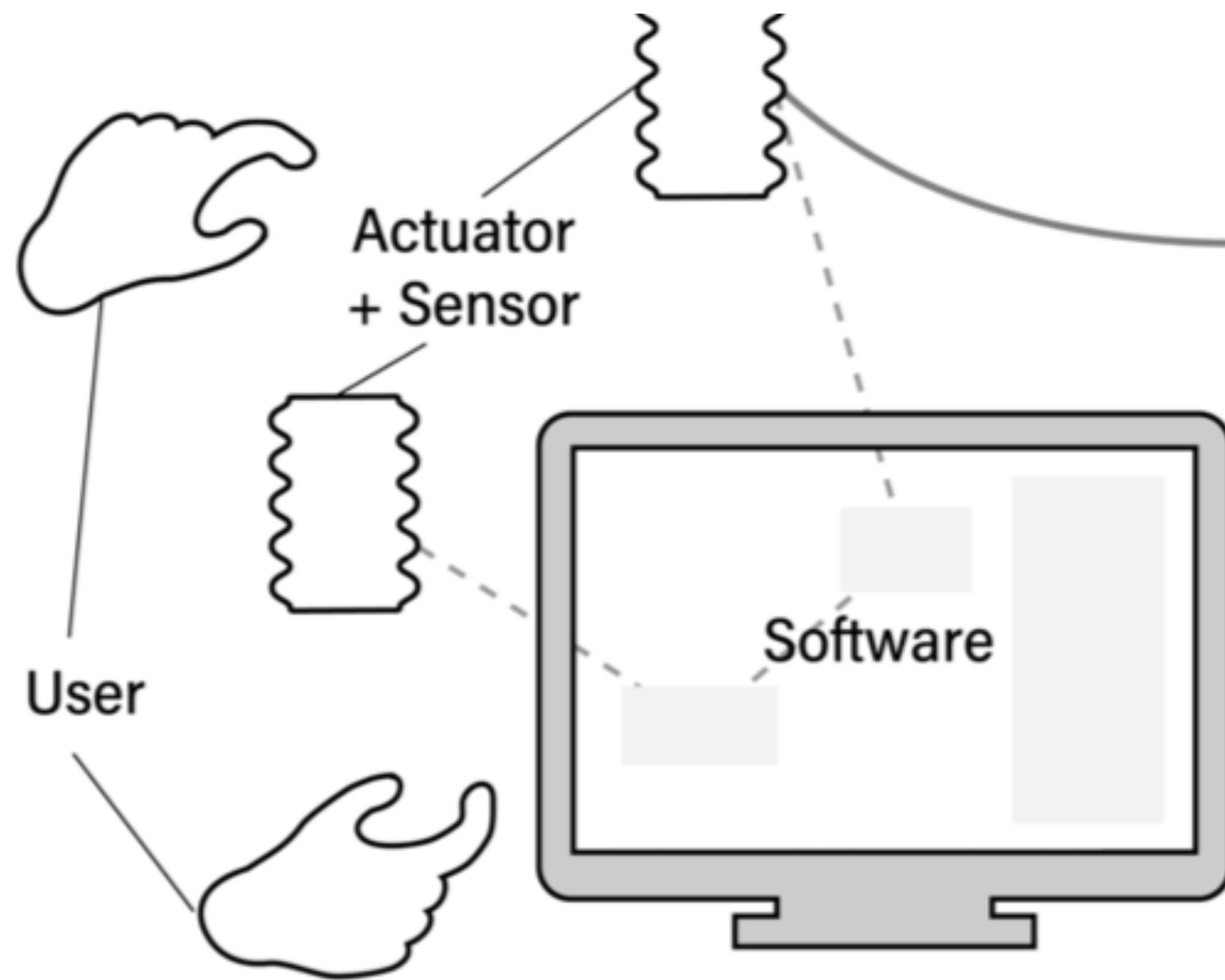
Background System



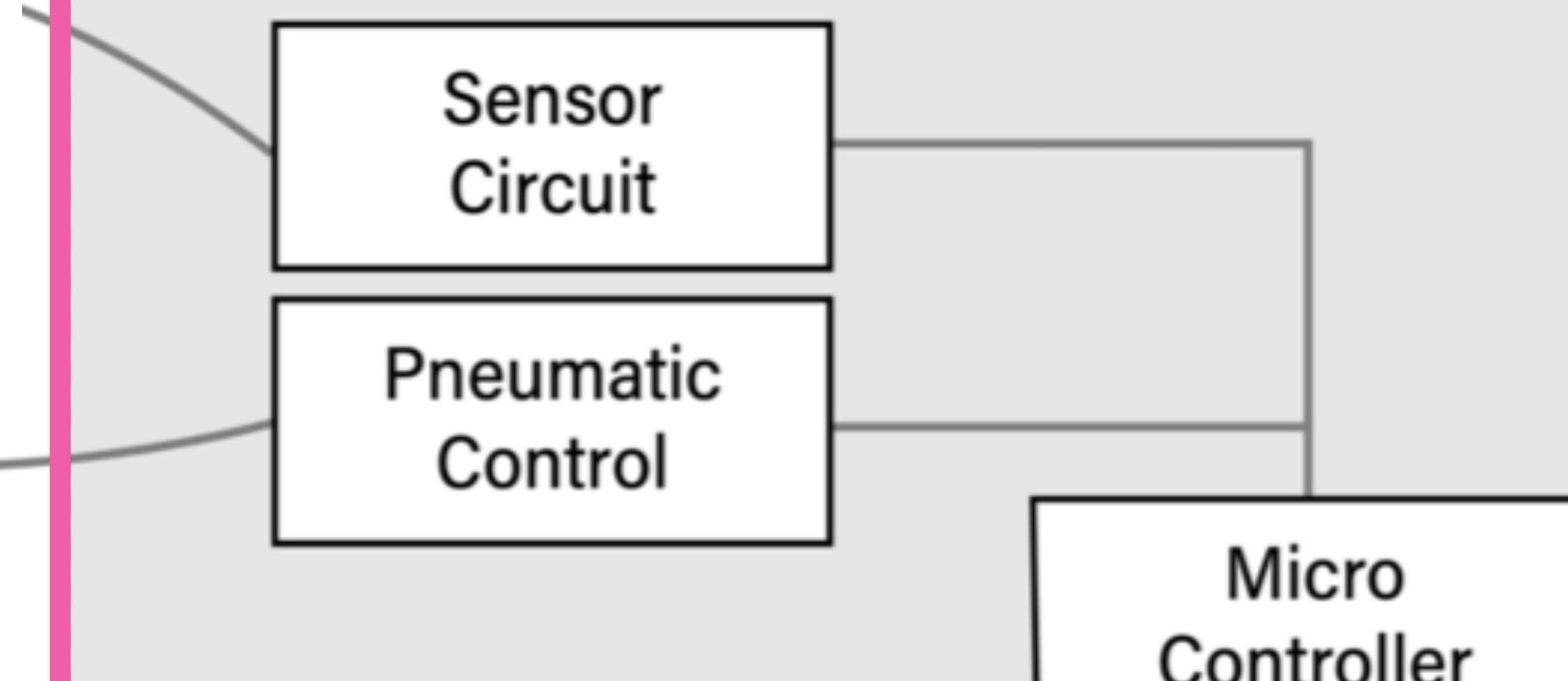


Visible to User

[2] Feedback System



Background System



Computer

Micro
Controller

Sensor
Circuit

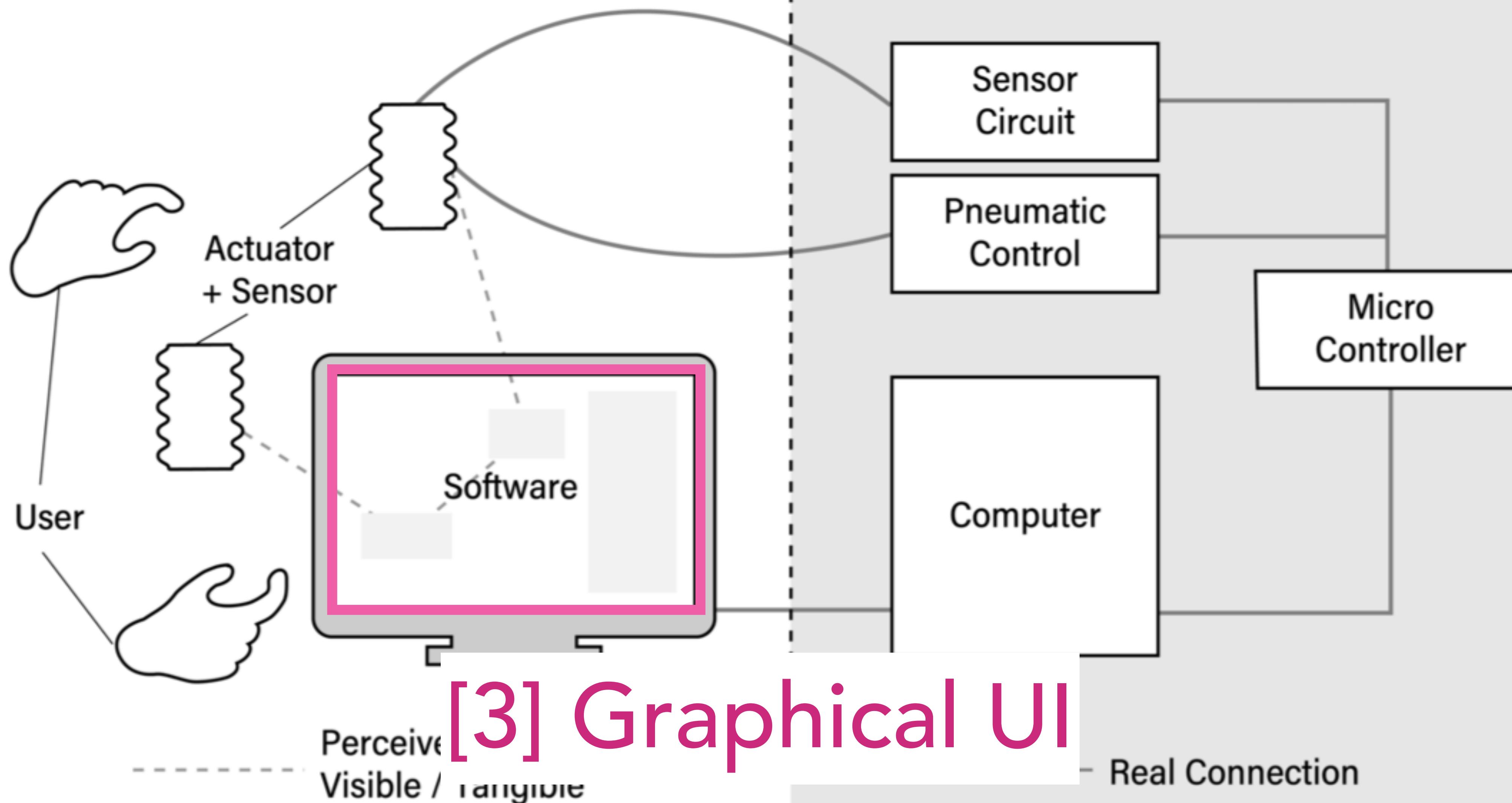
Pneumatic
Control

Real Connection

Perceived Connection
Visible / Tangible

Visible to User

Background System

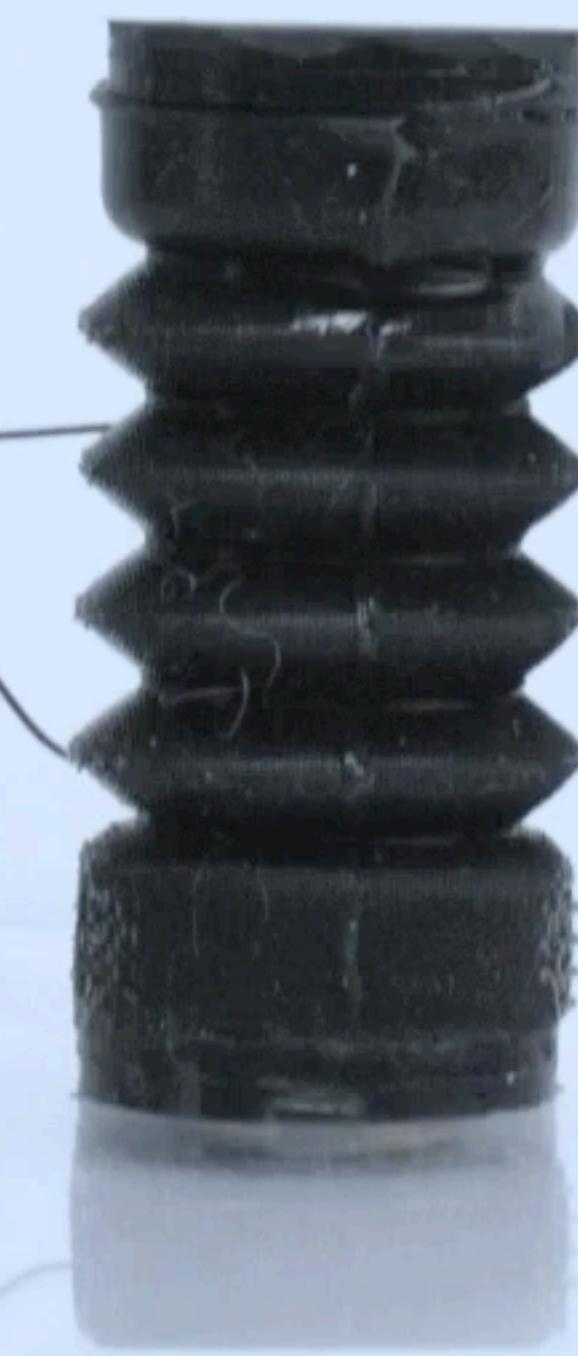


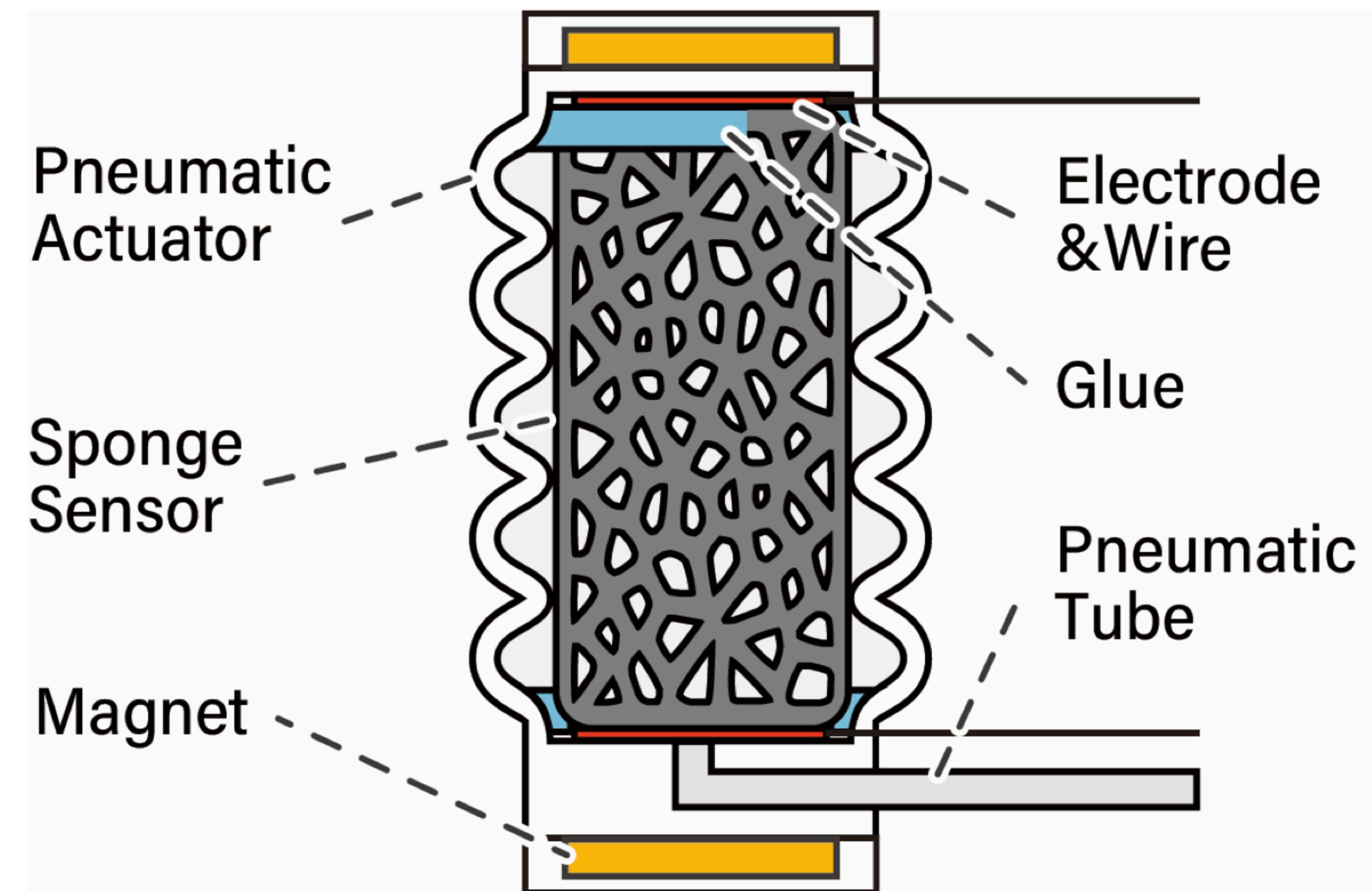
[3] Graphical UI

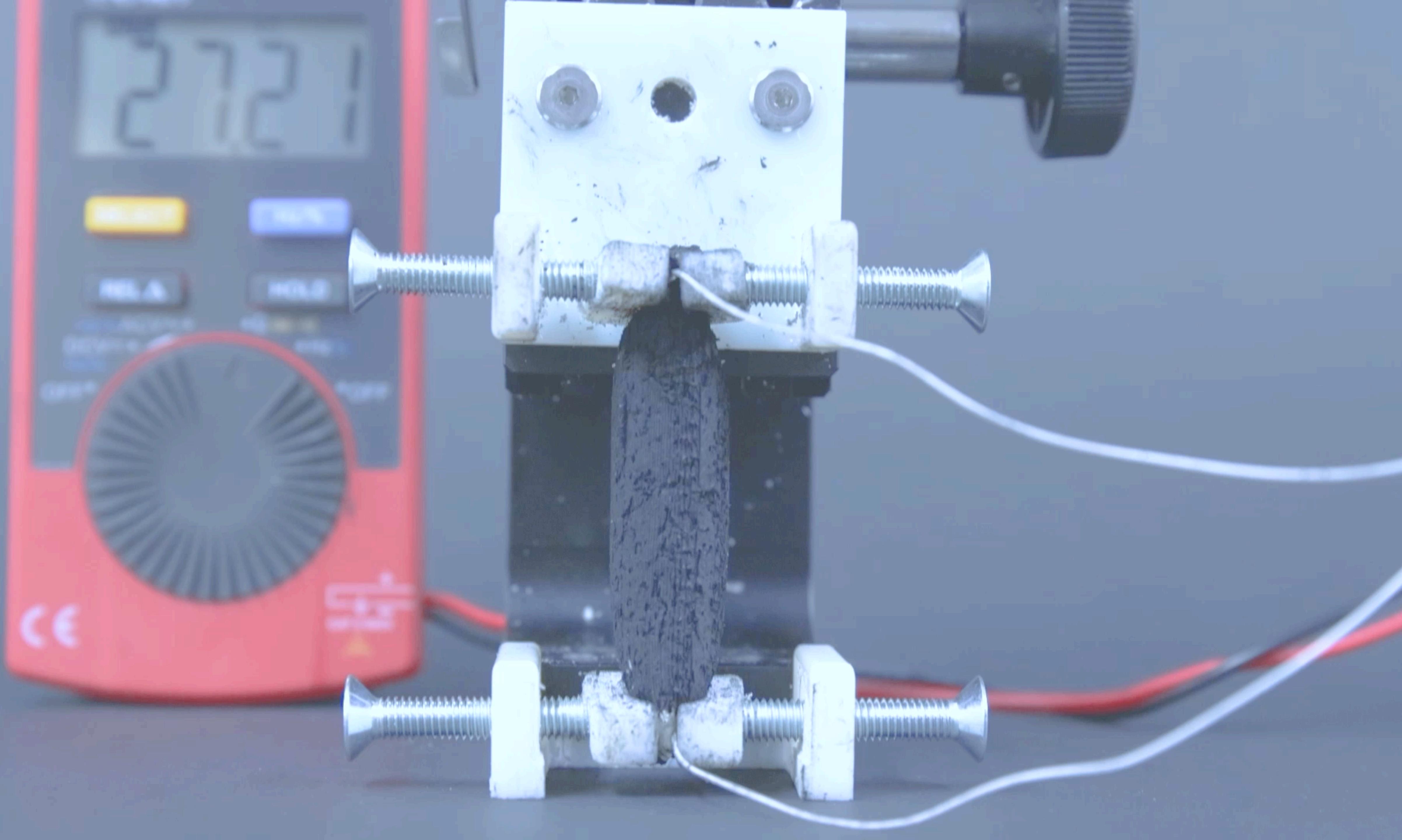
Entirely Soft I/O

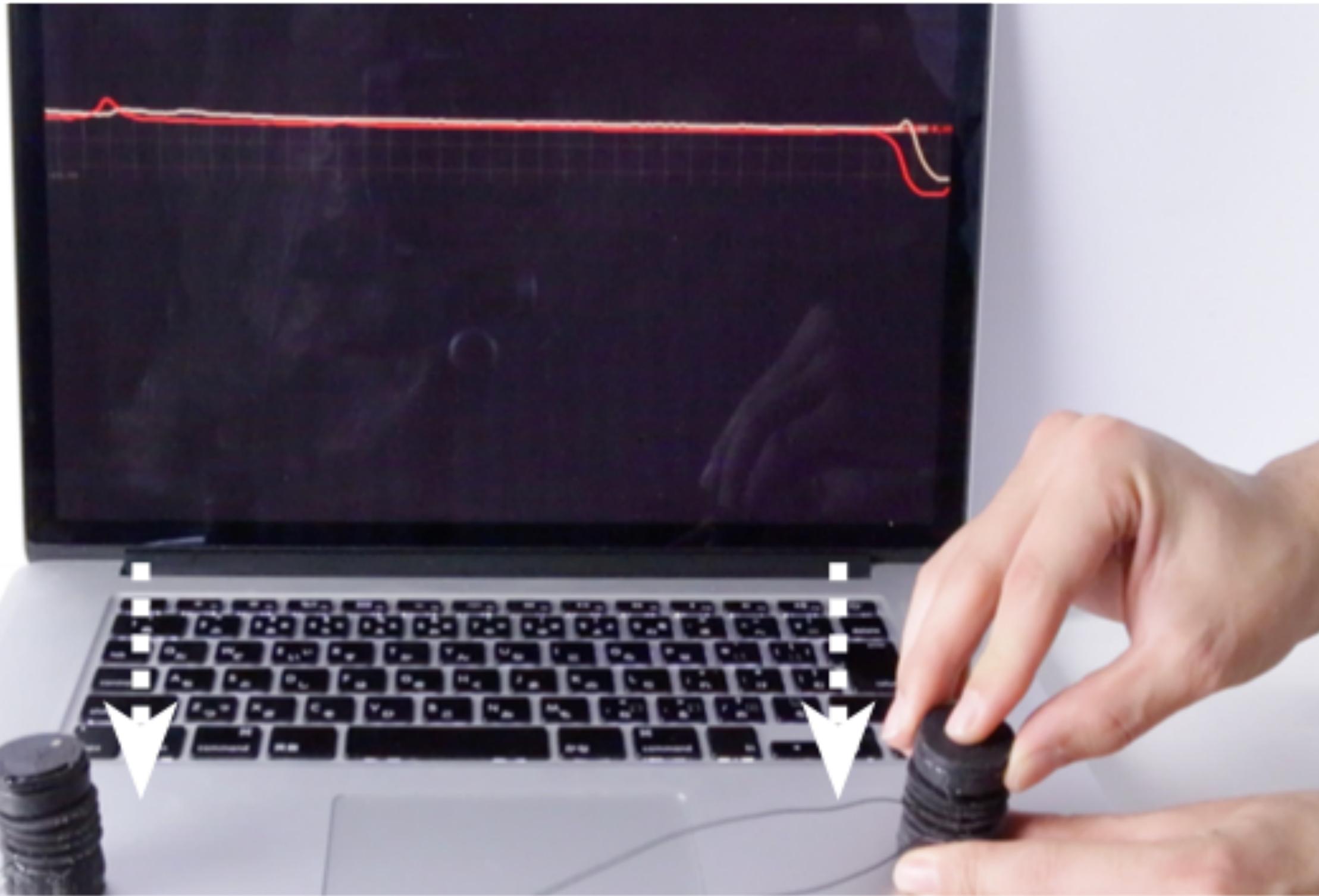
Programming Method

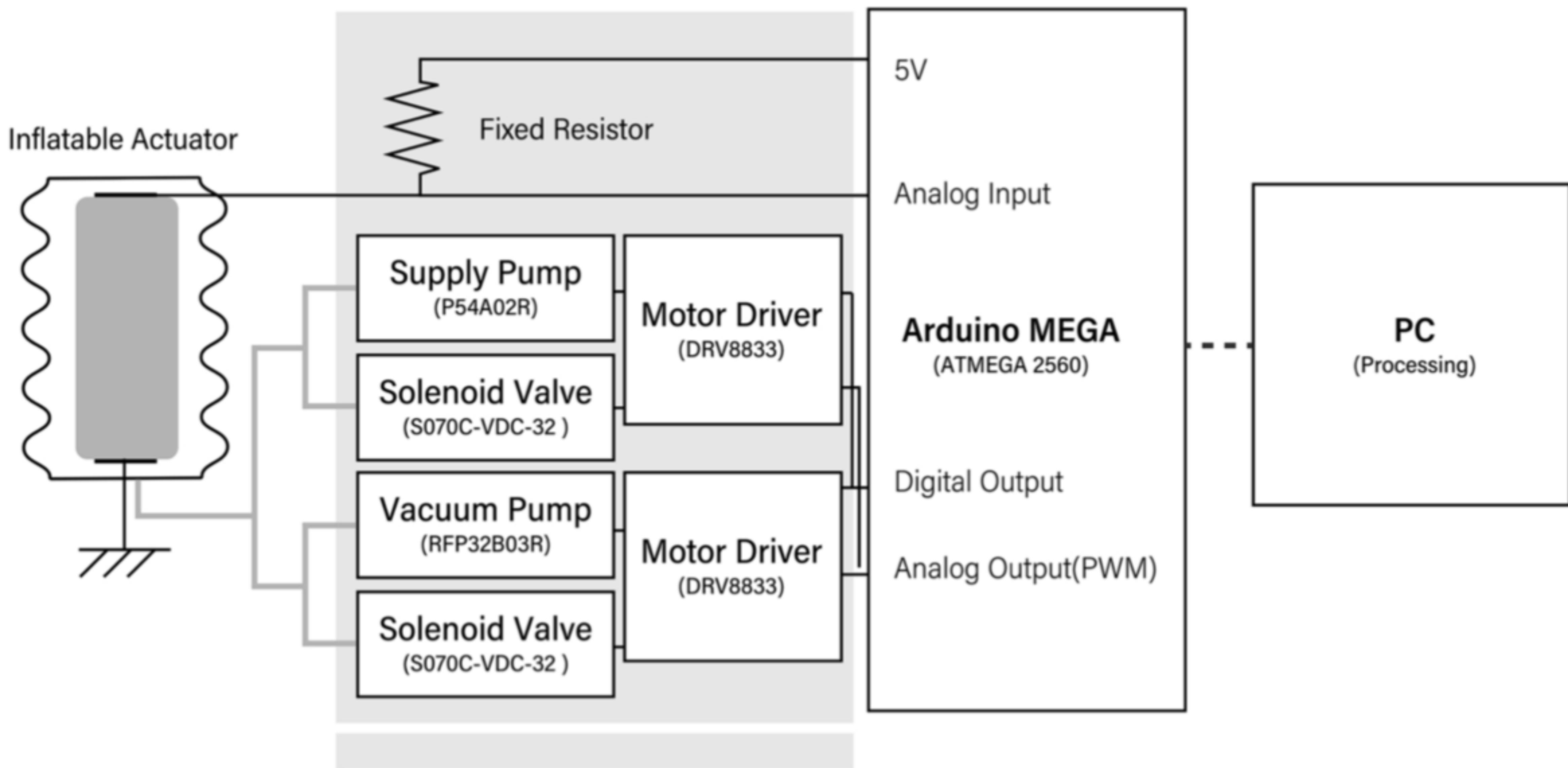
Record & Playback

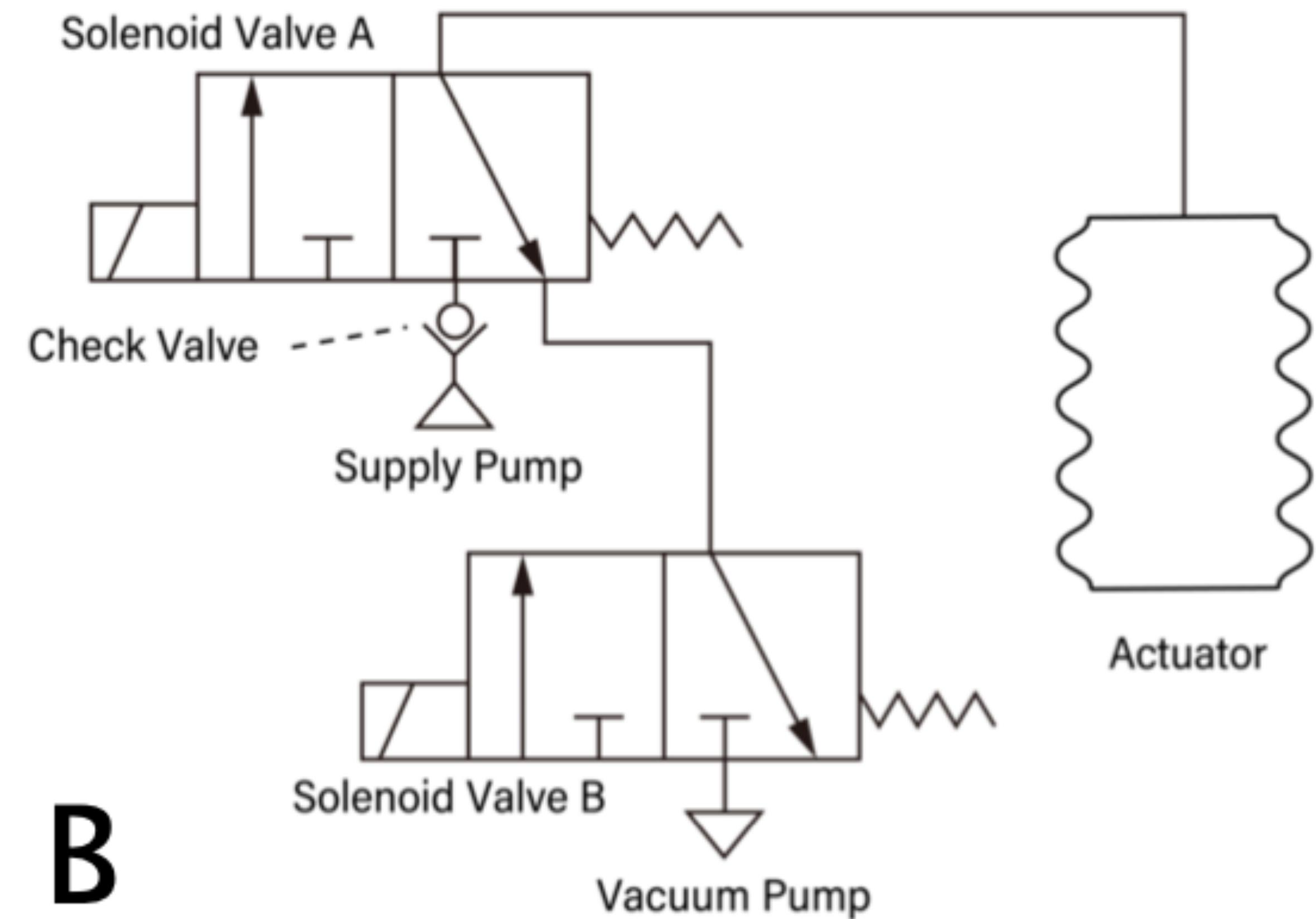
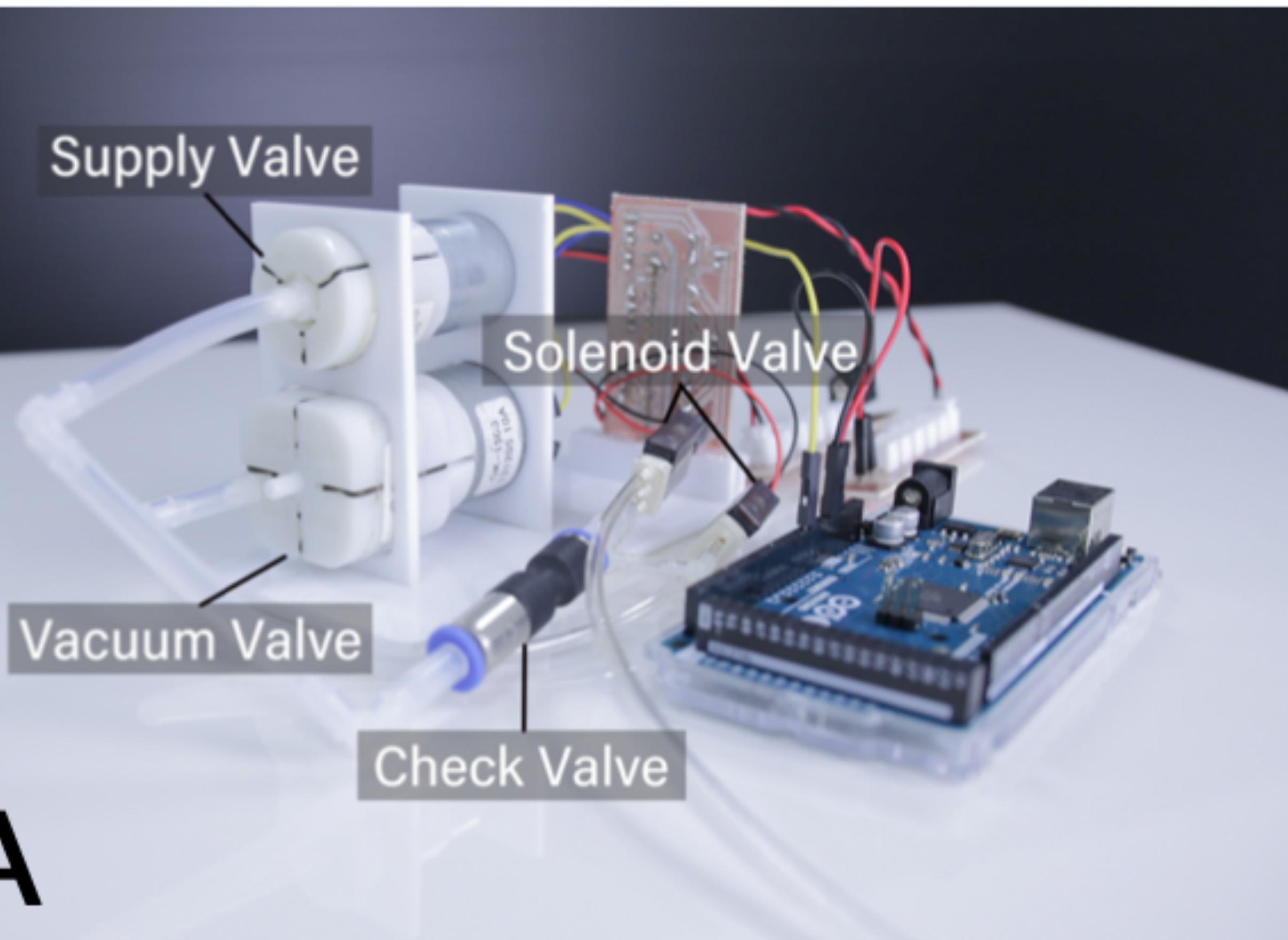




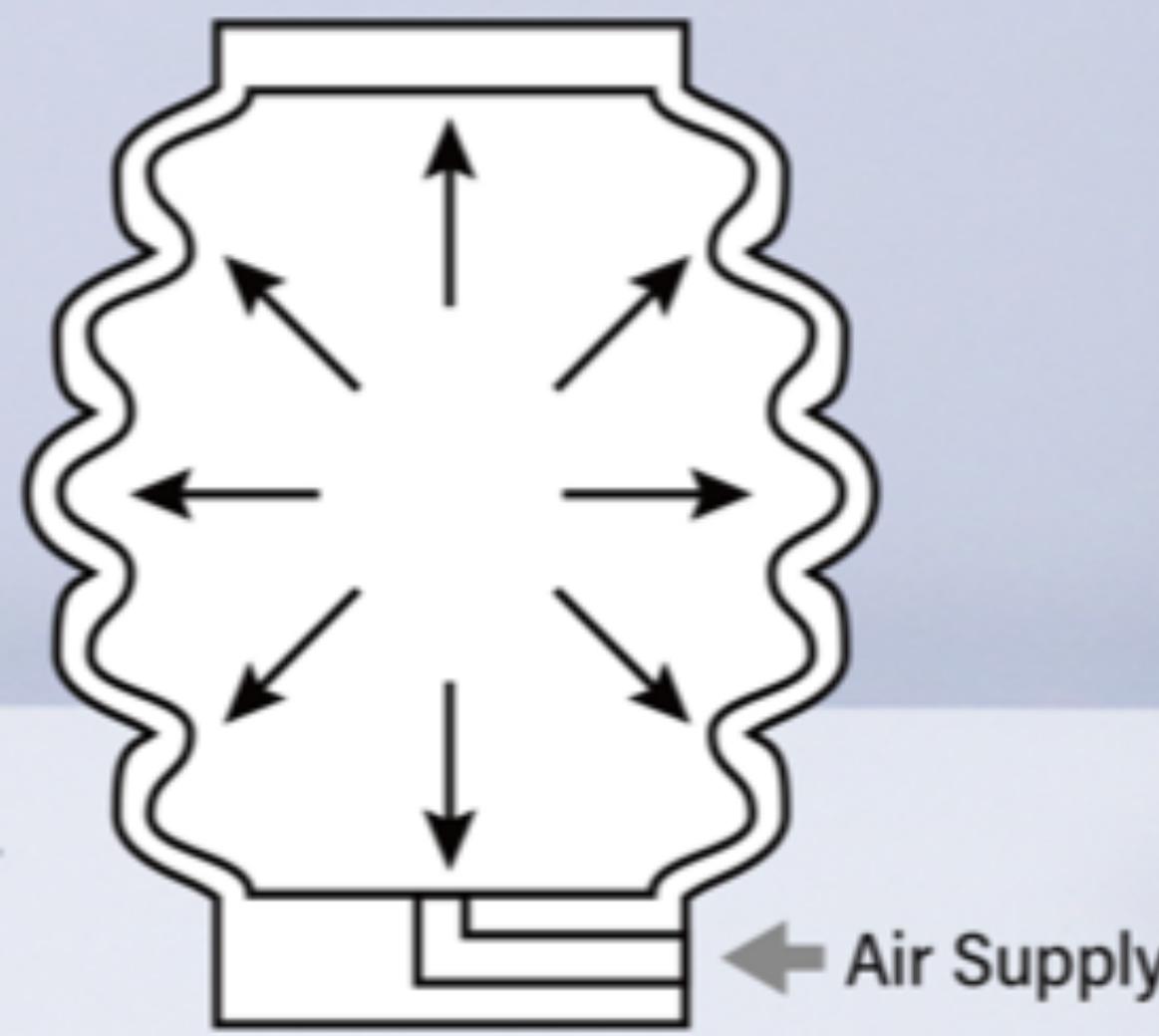




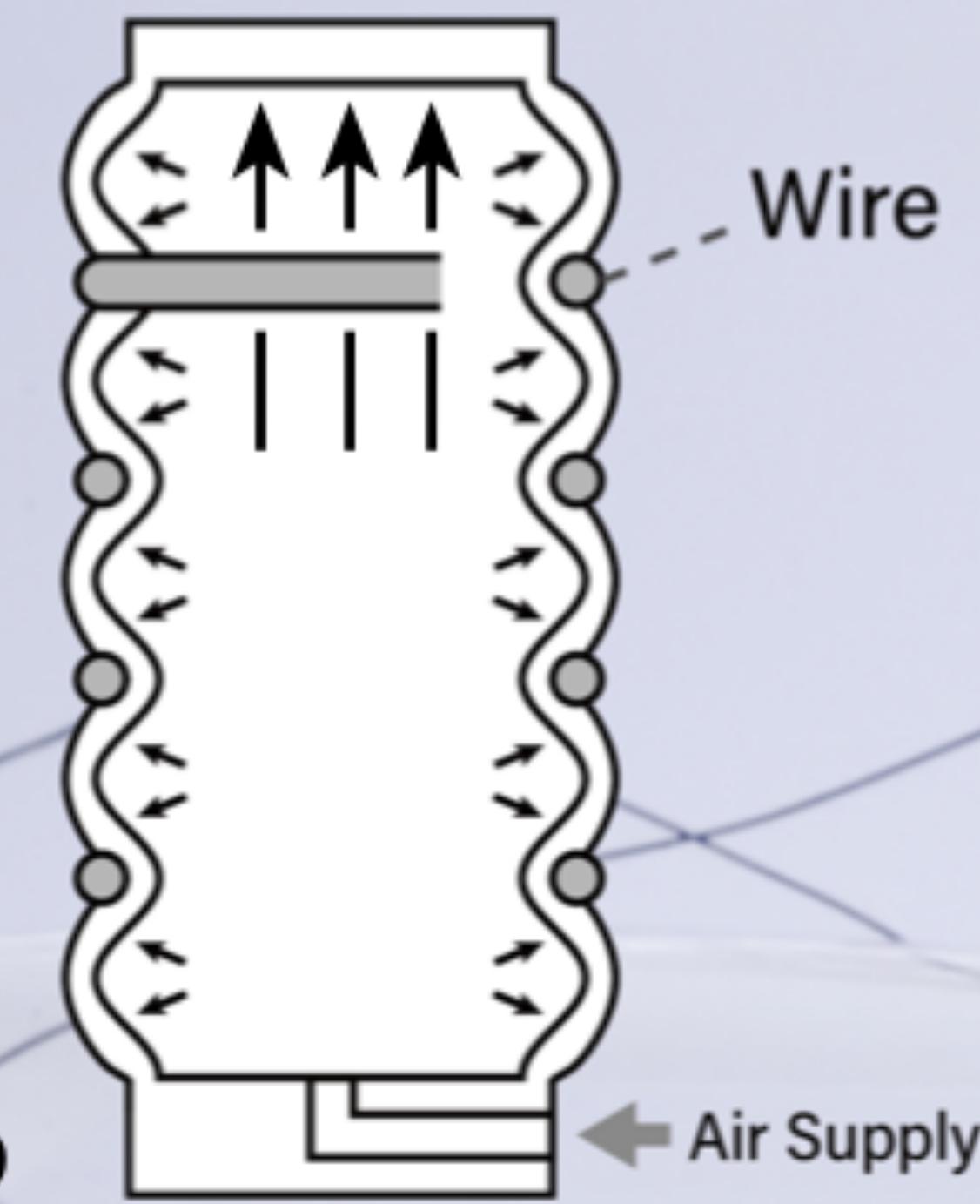


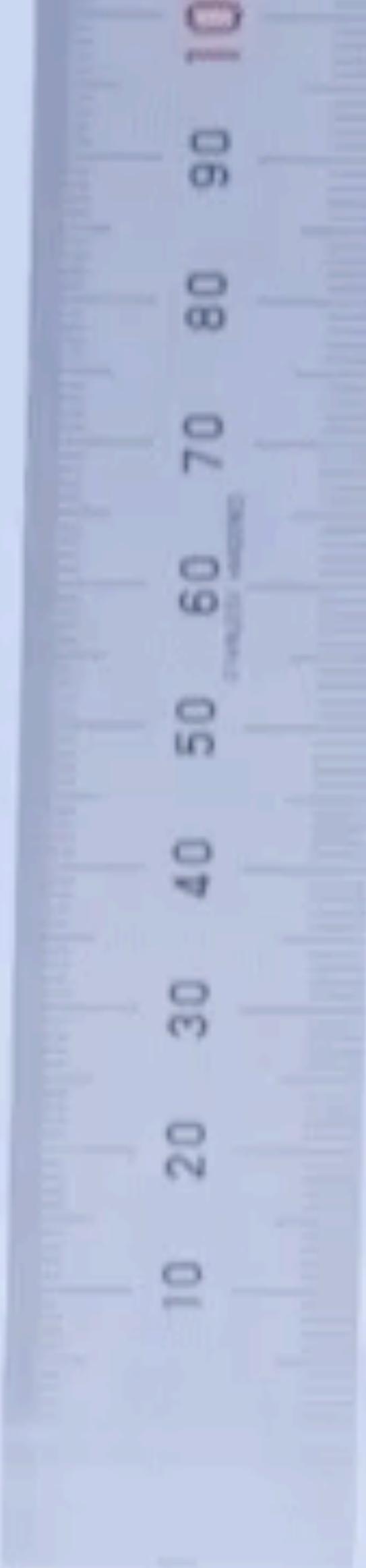


A



B



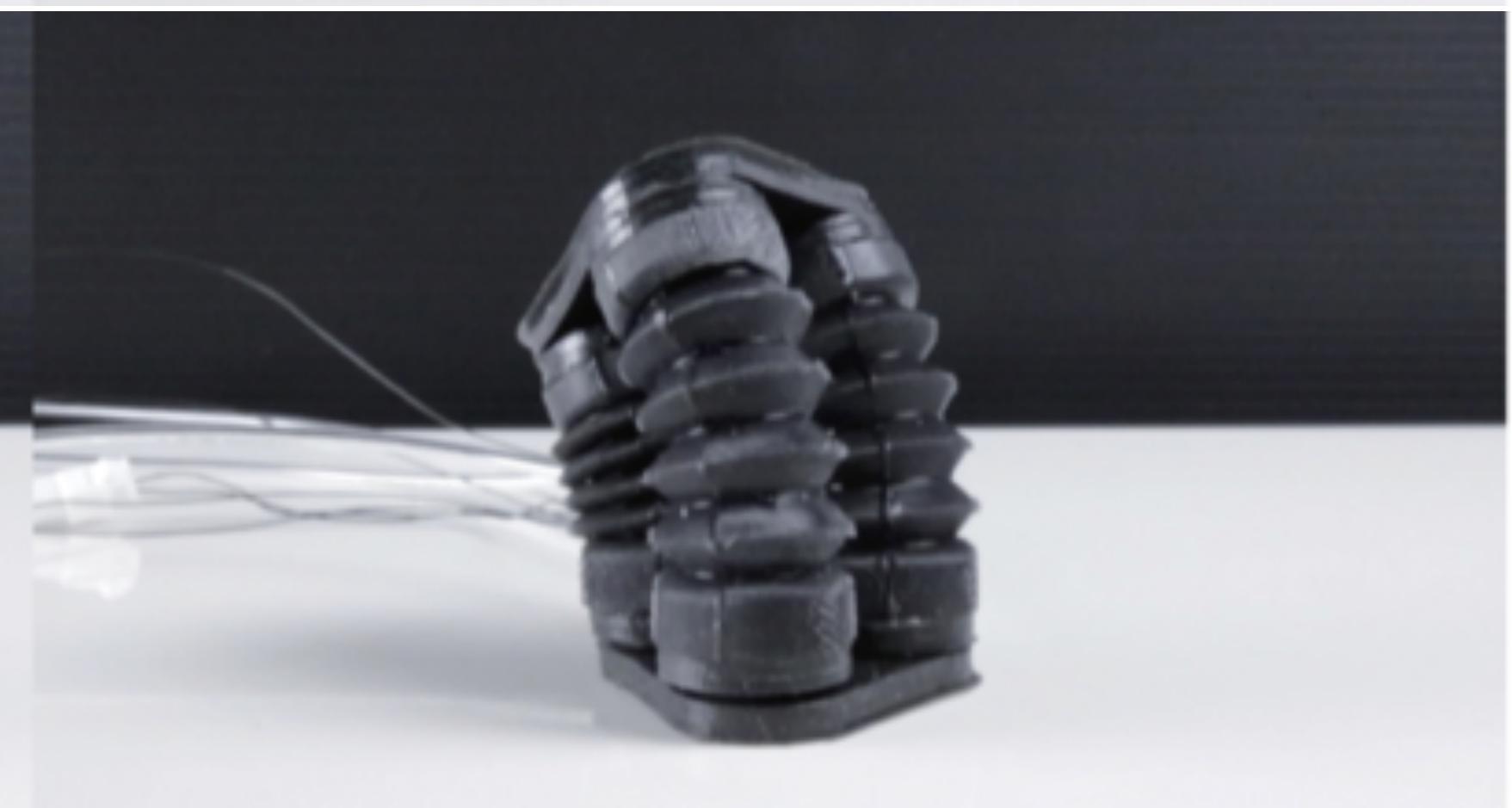
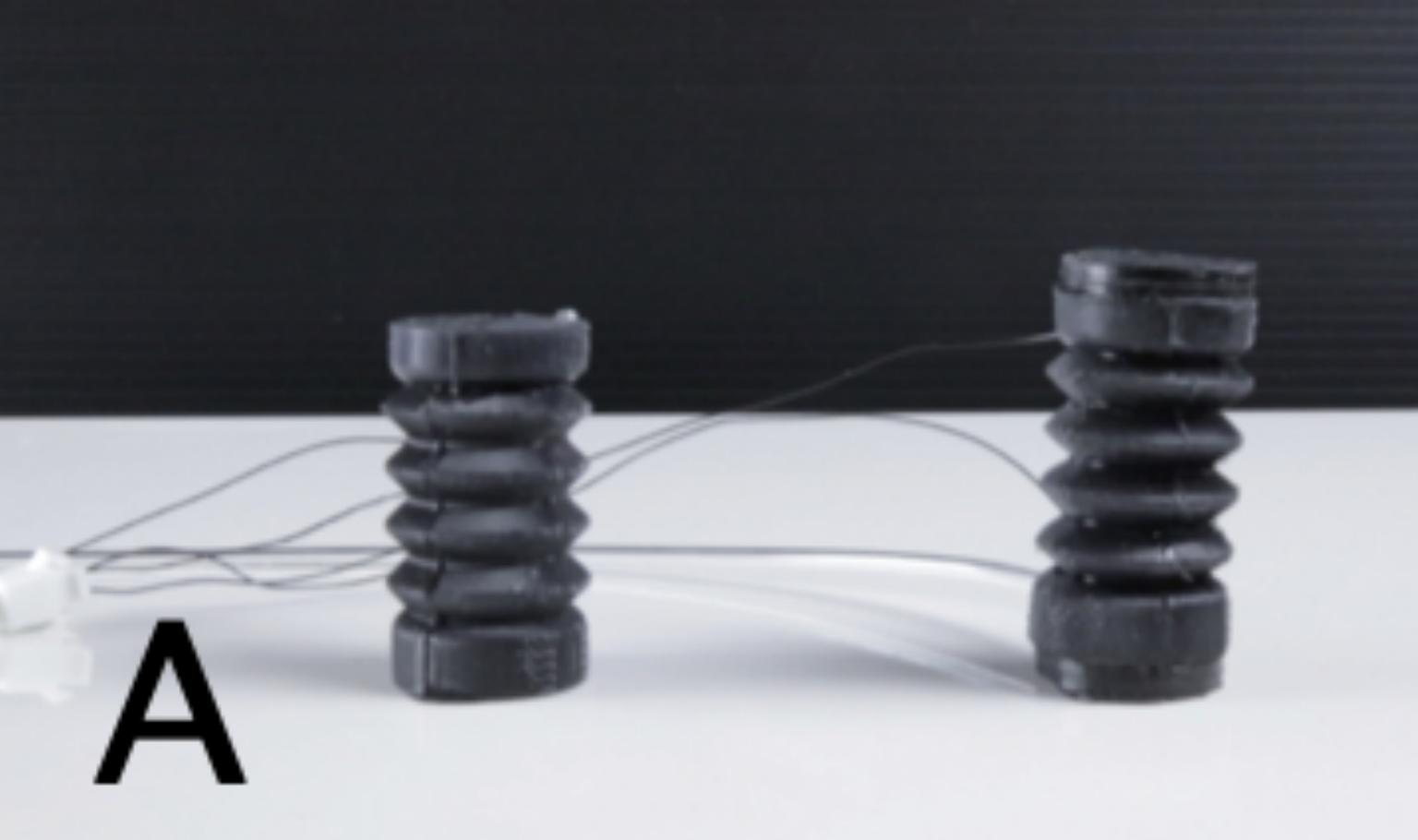


78%

138%

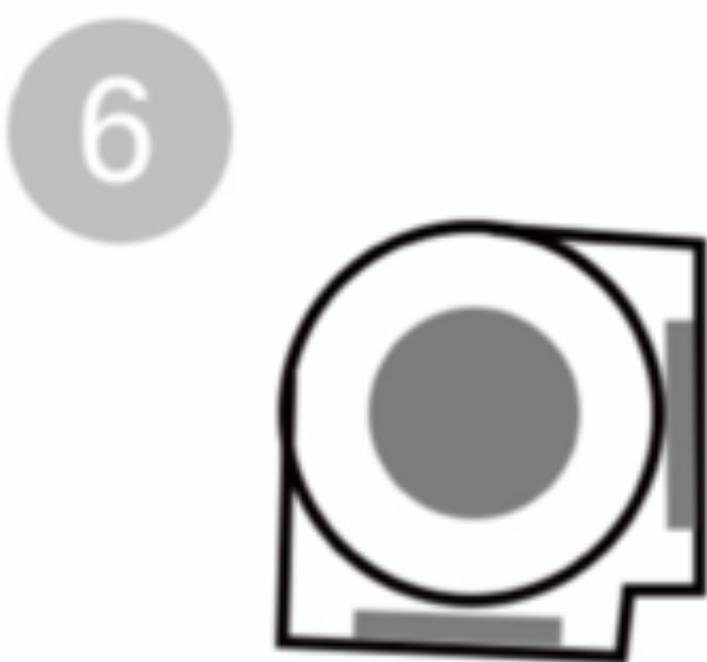
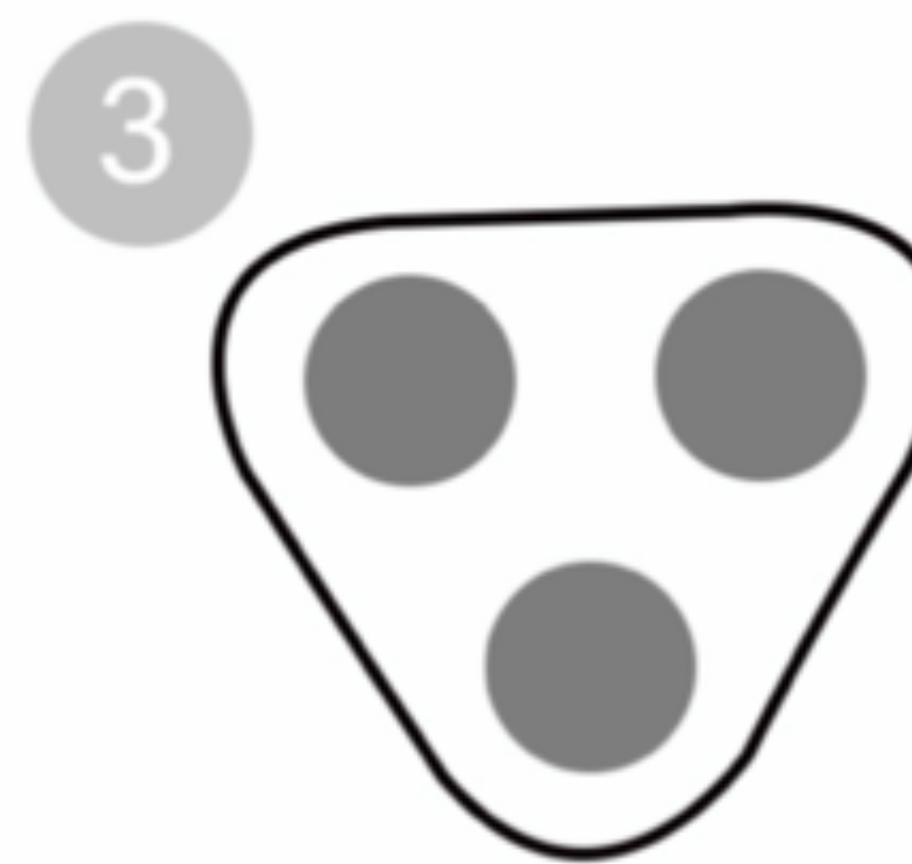
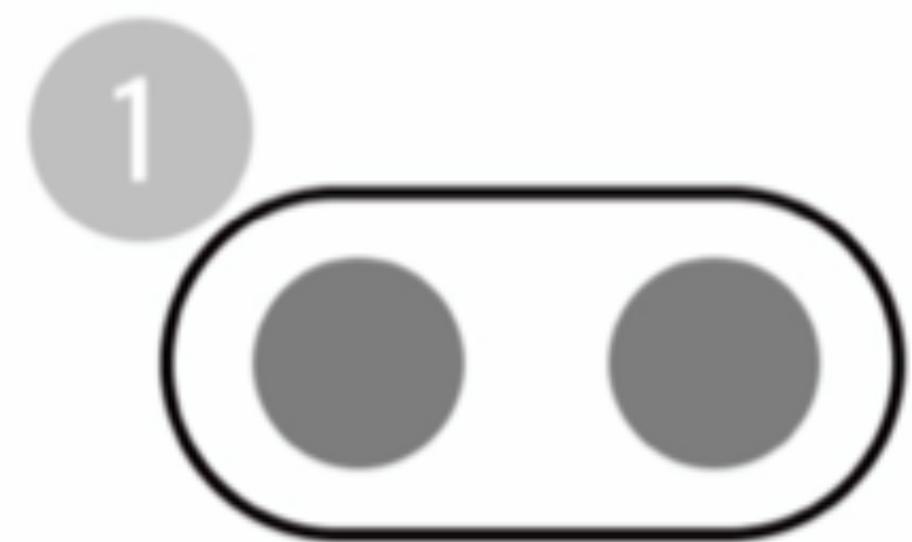
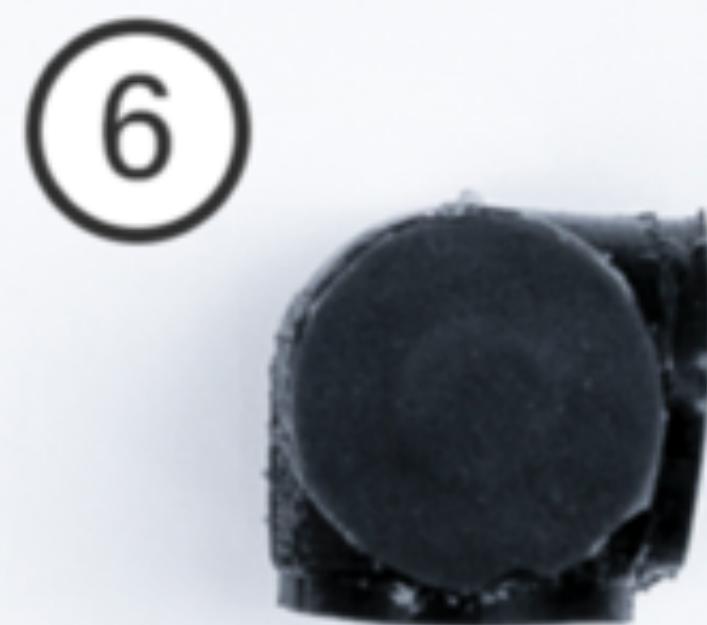
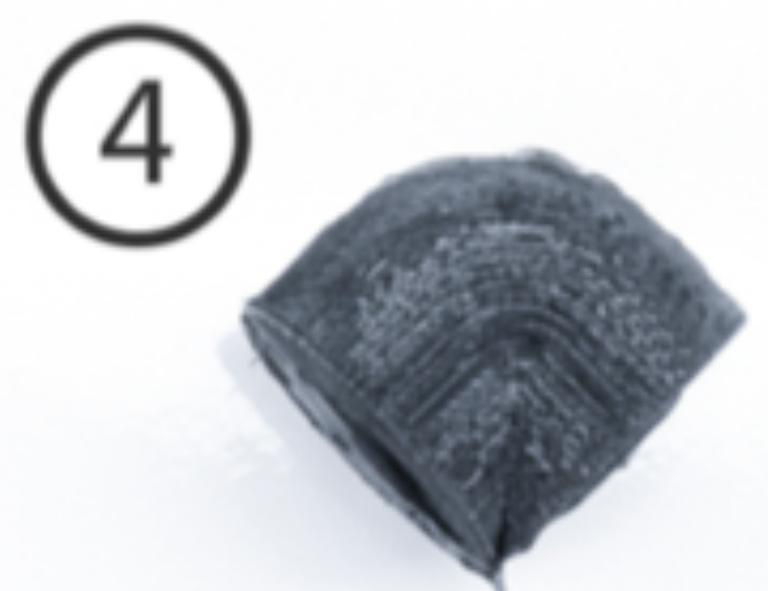


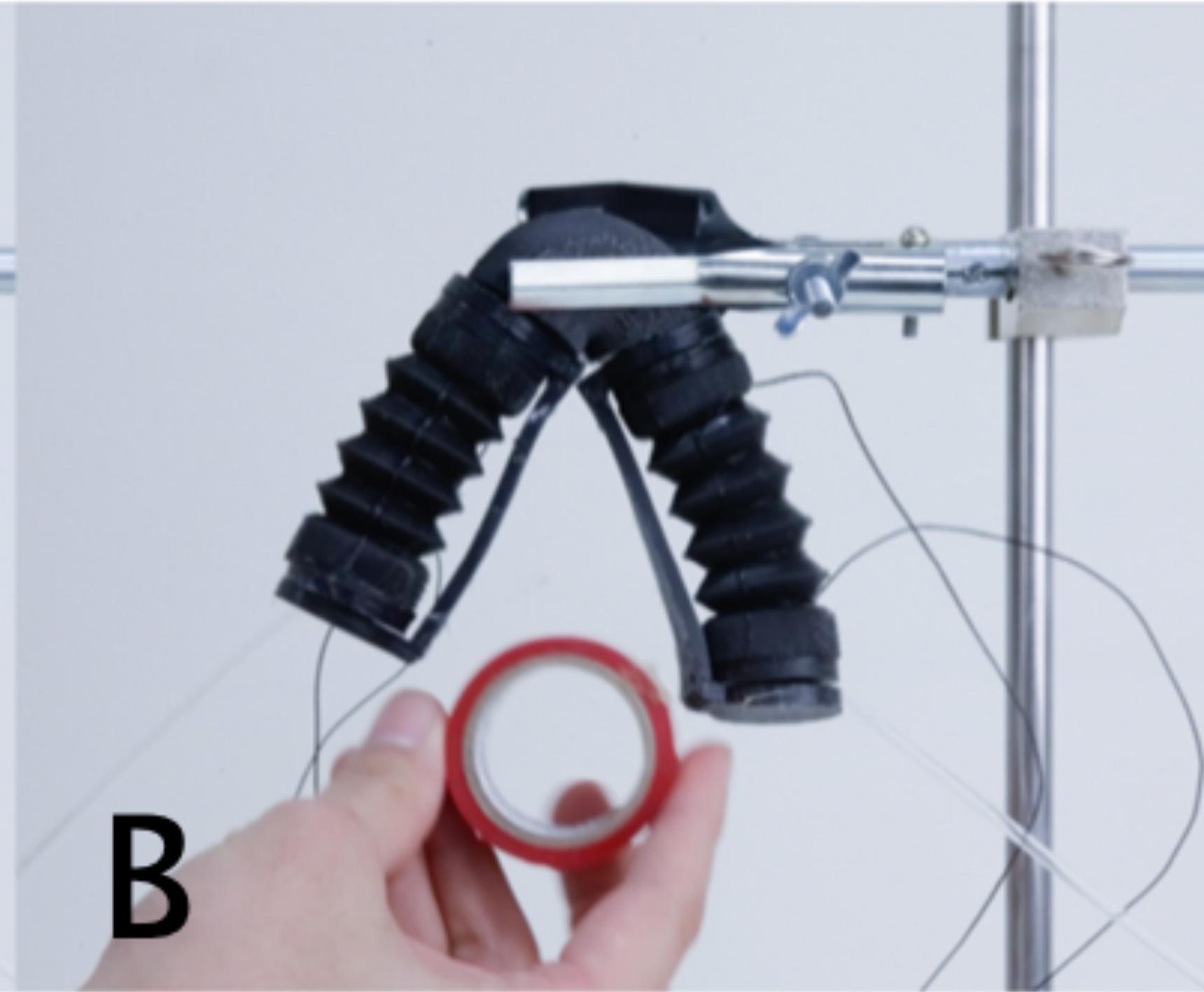
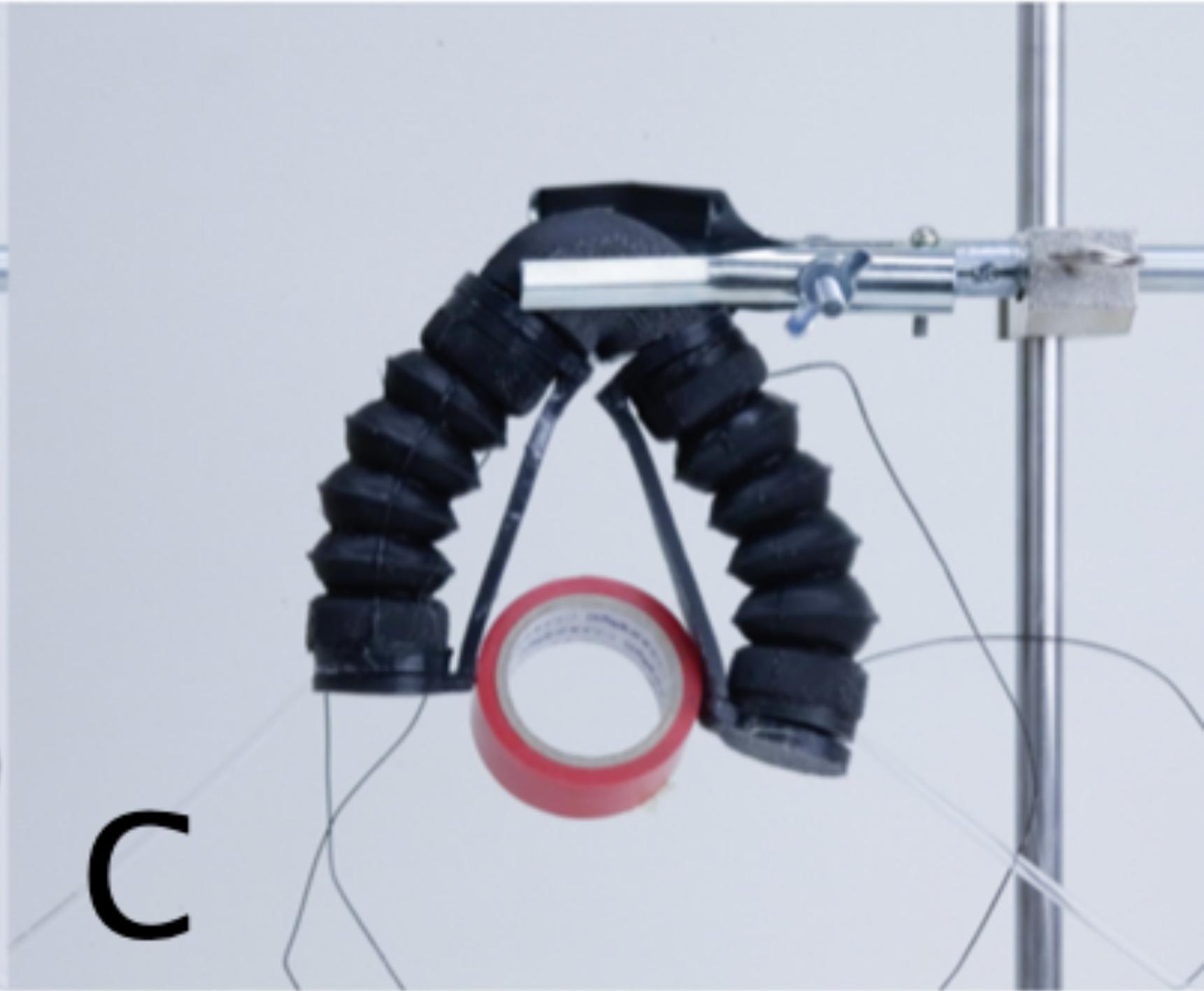
Modular Design









A**B****C**

Fabrication Process



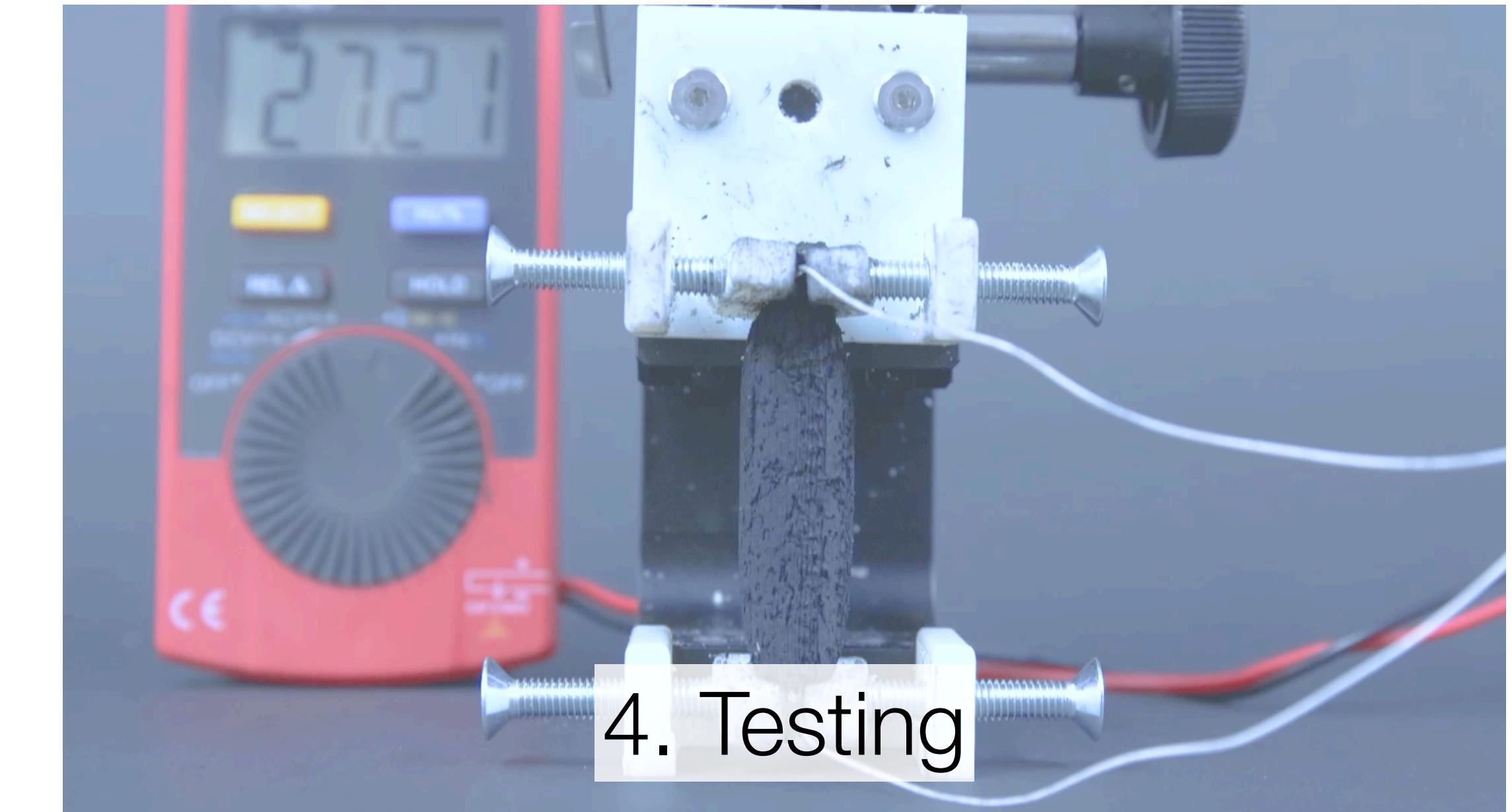
1. Make an Elastic Foam



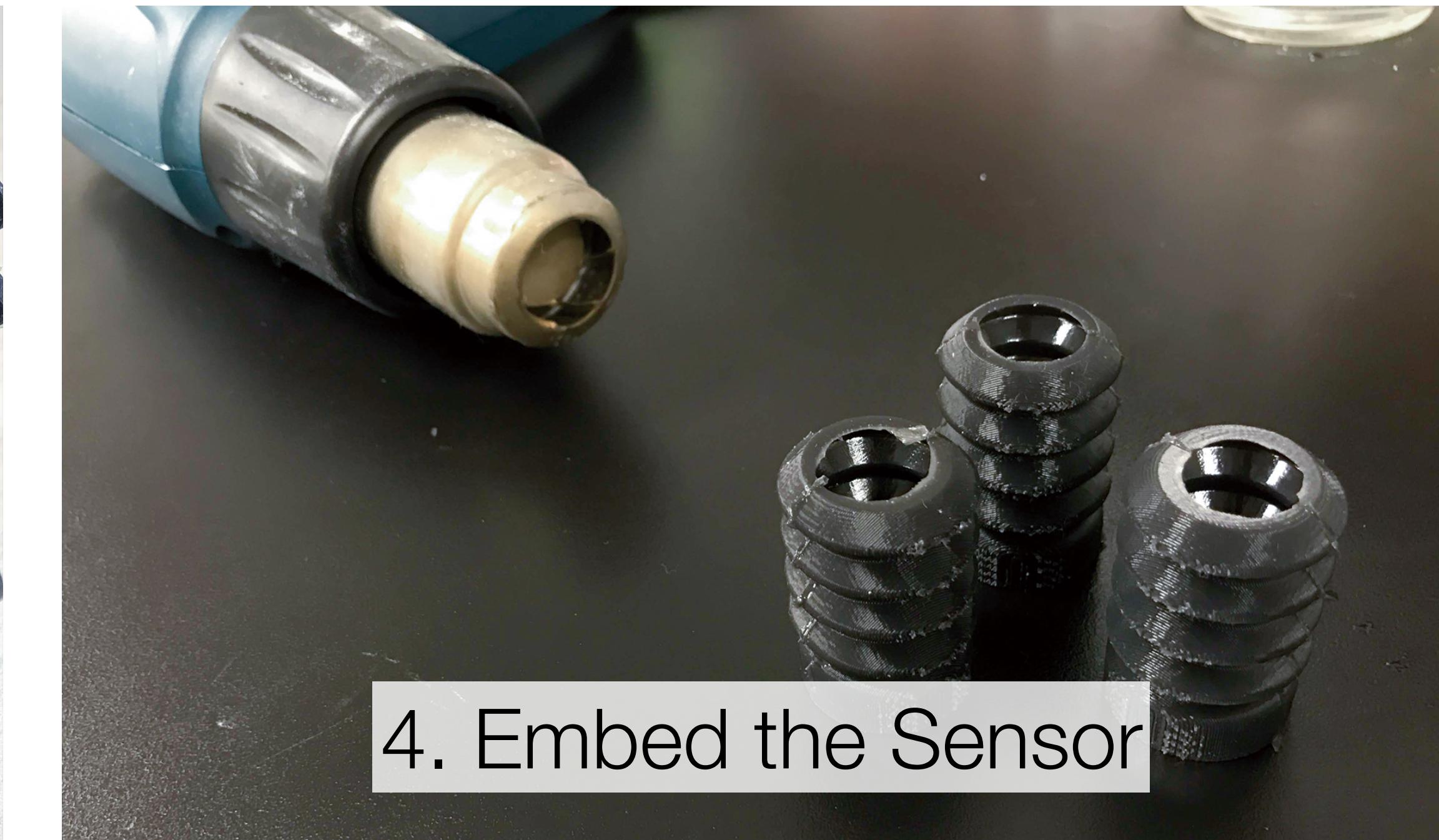
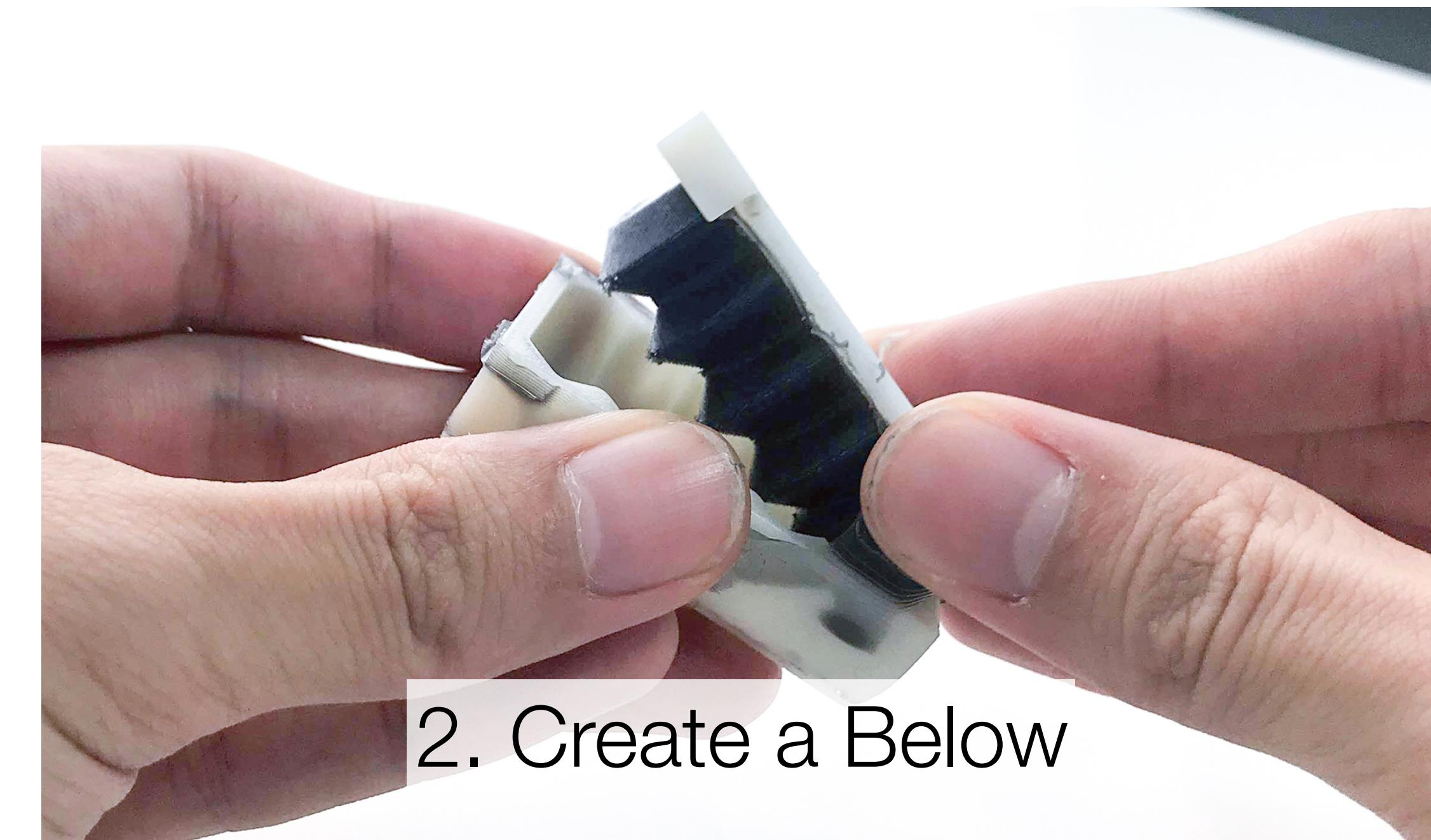
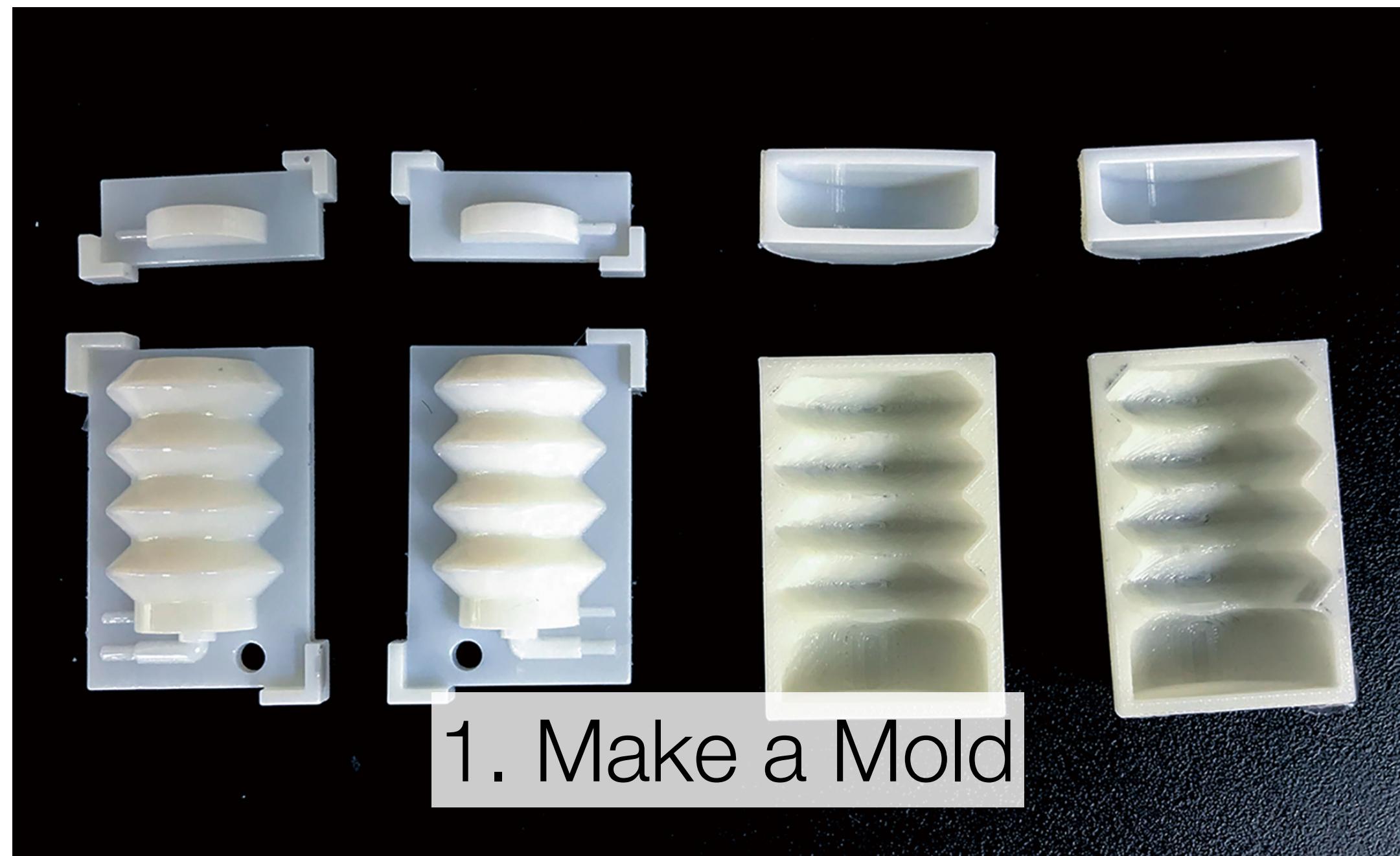
2. Make a Conductive Ink



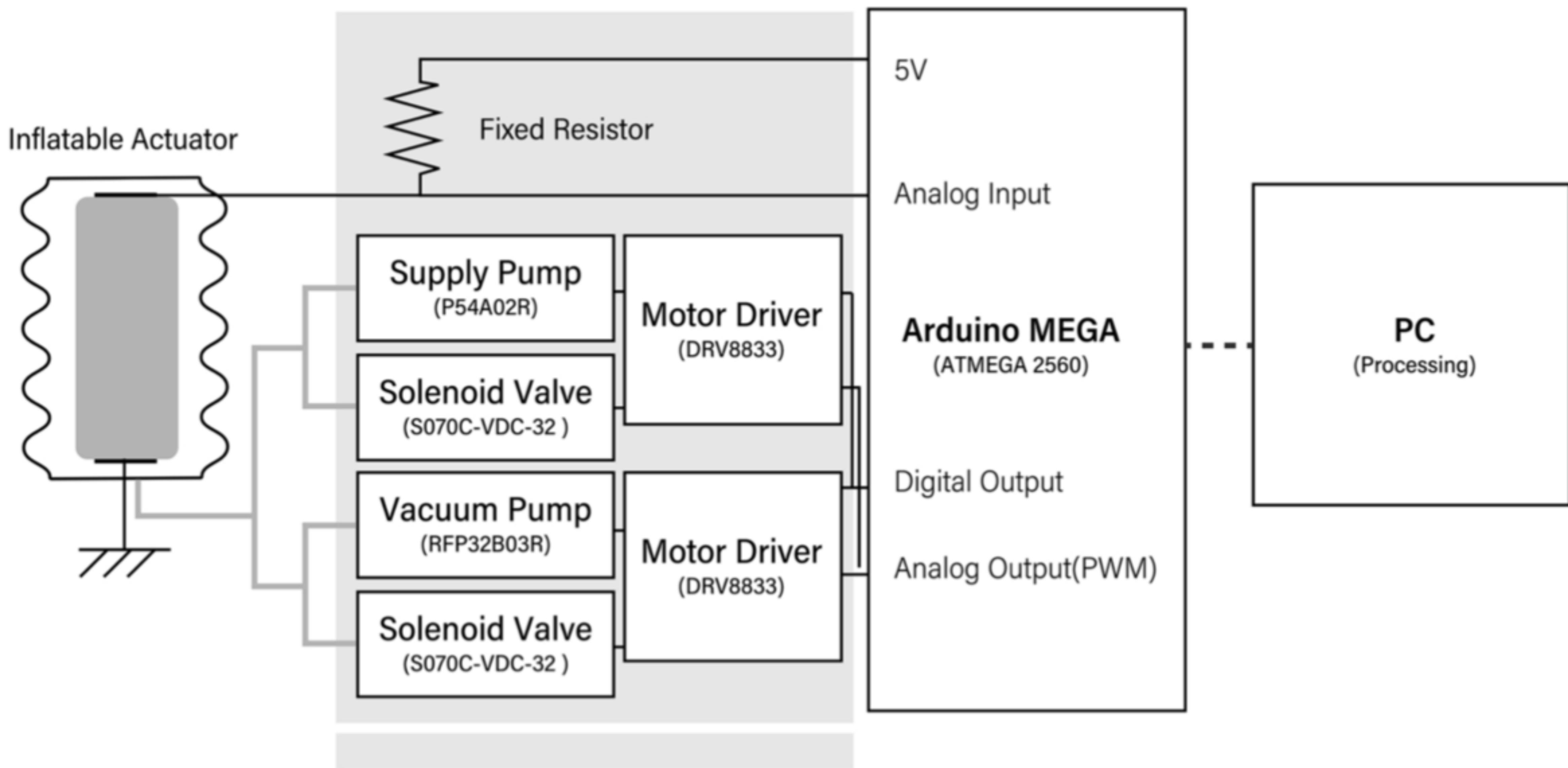
3. Mix

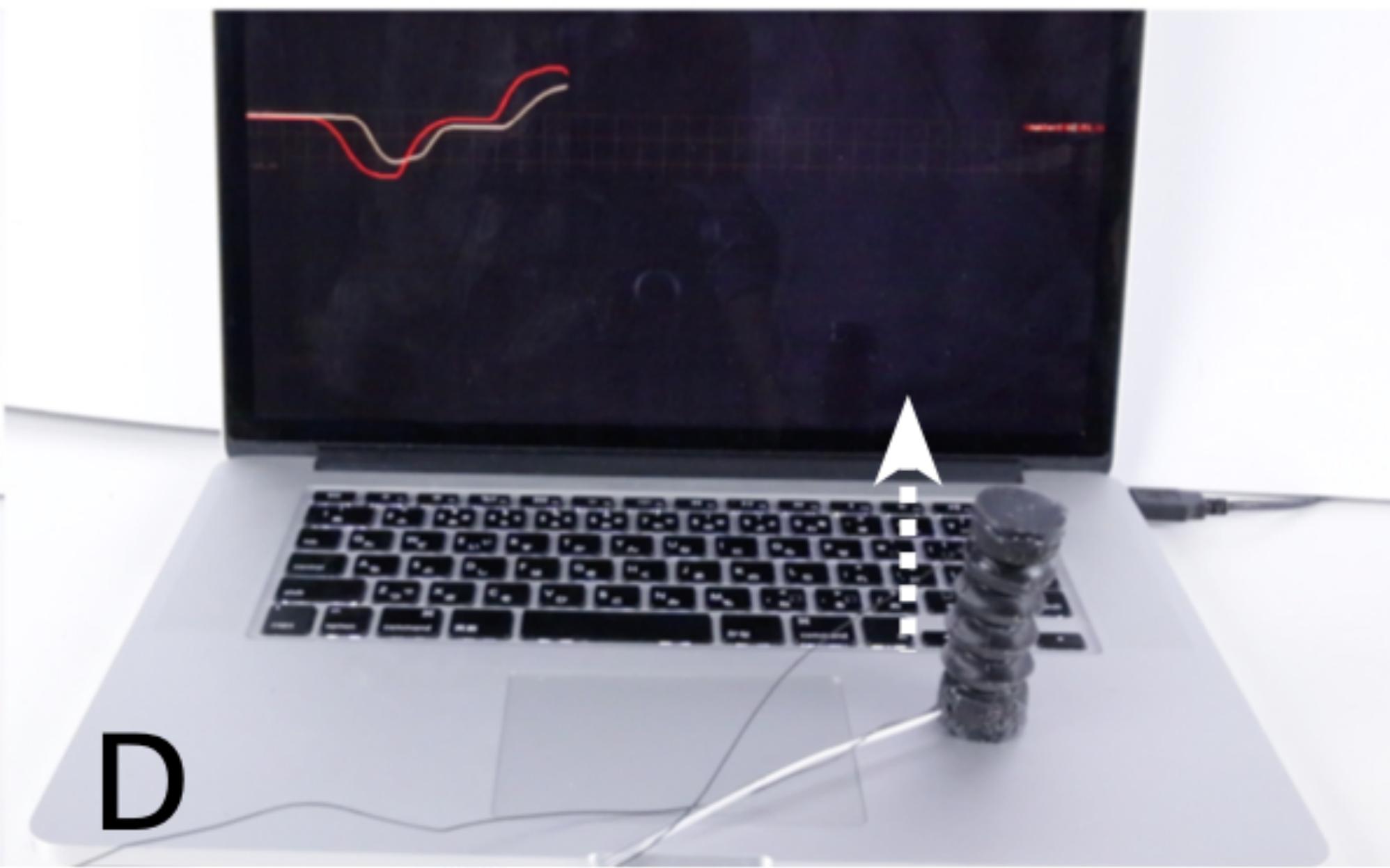
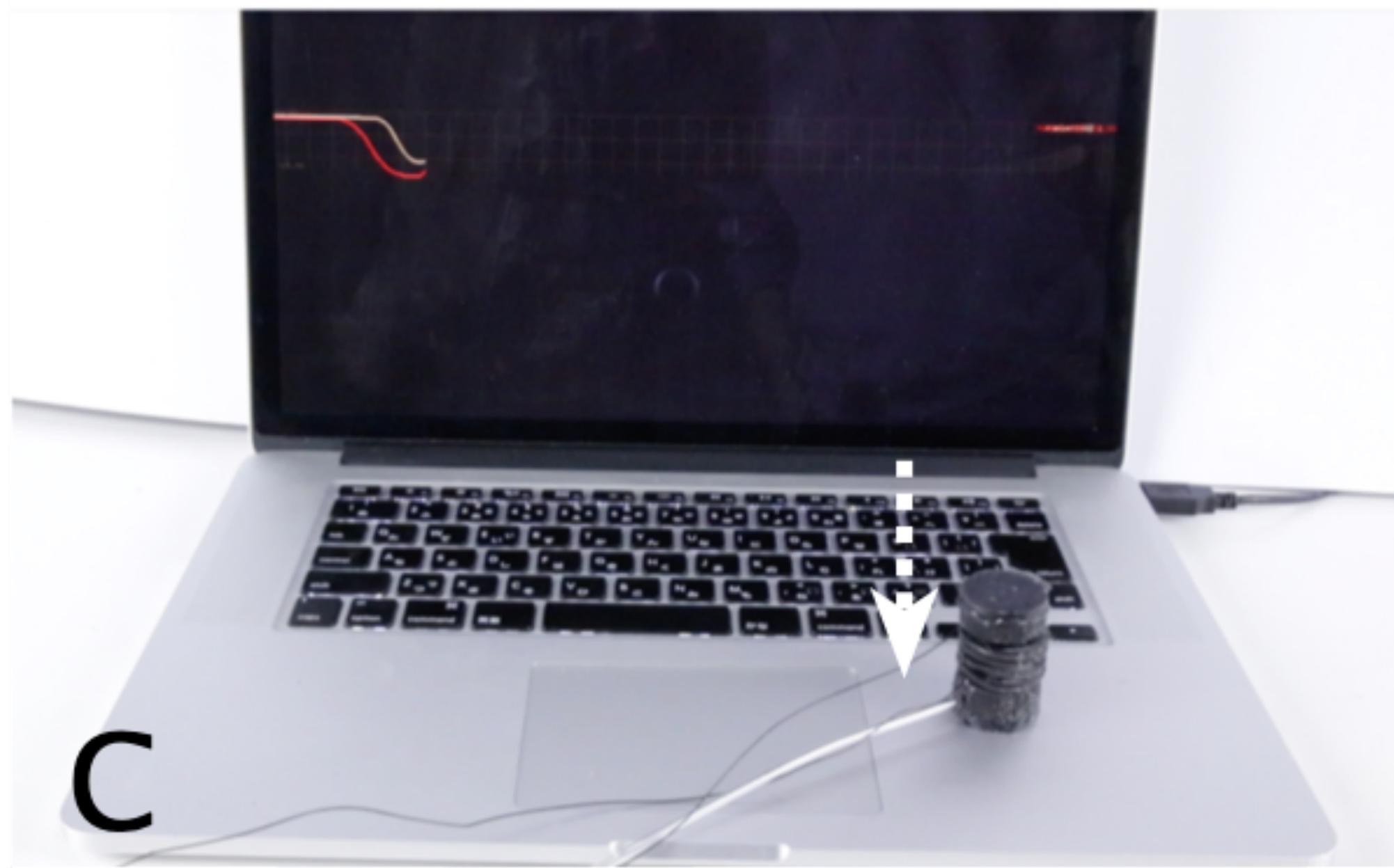
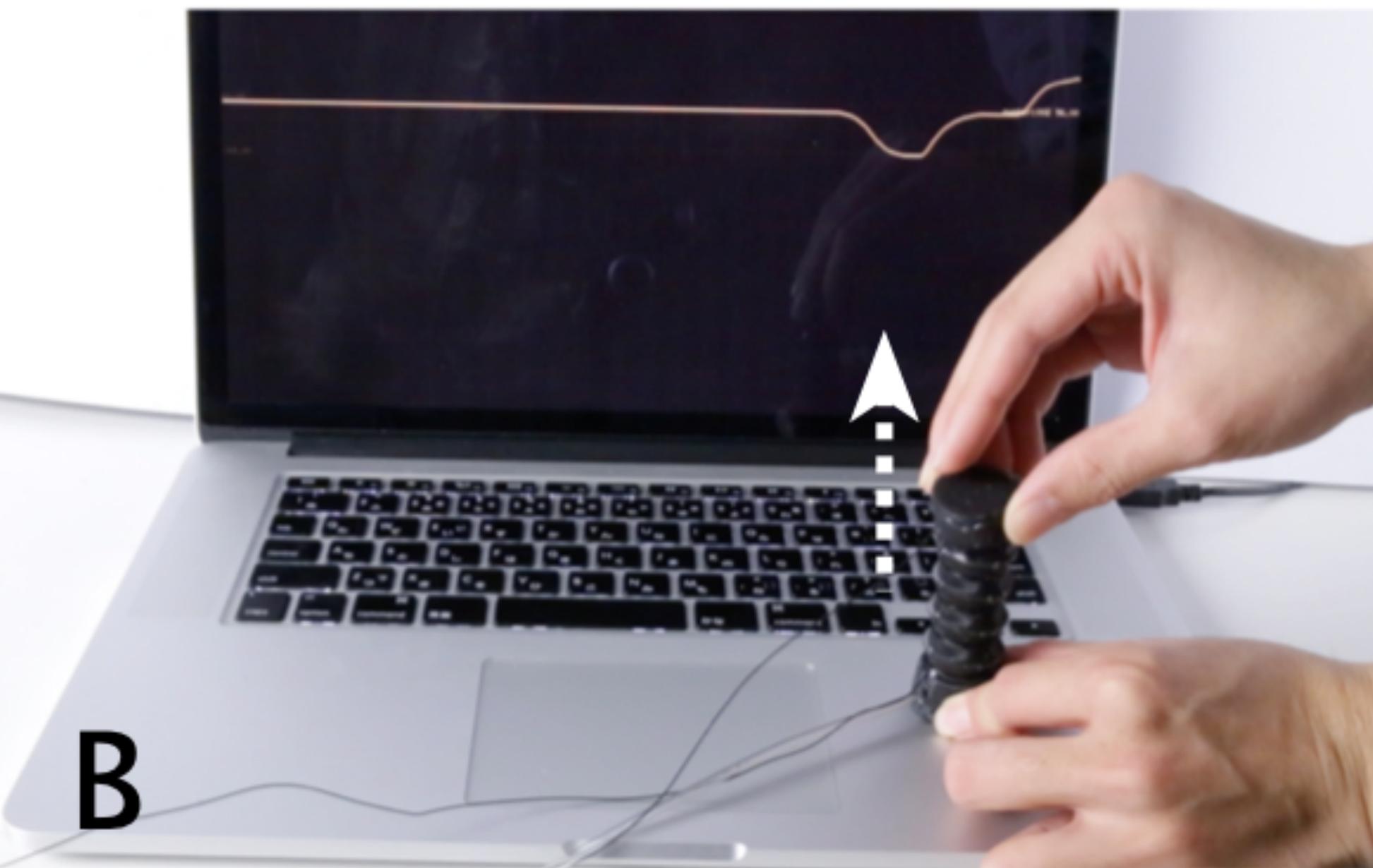


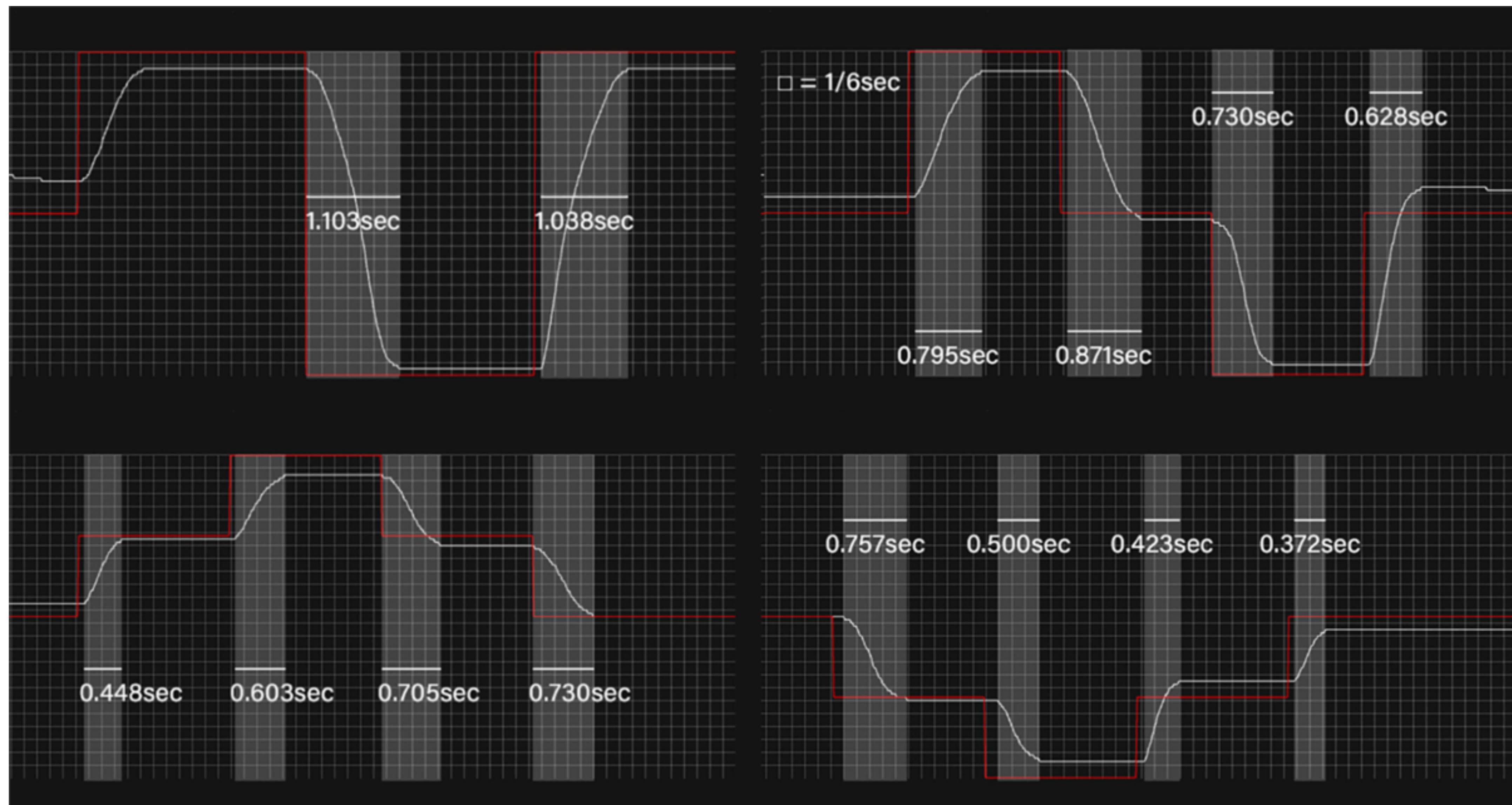
4. Testing

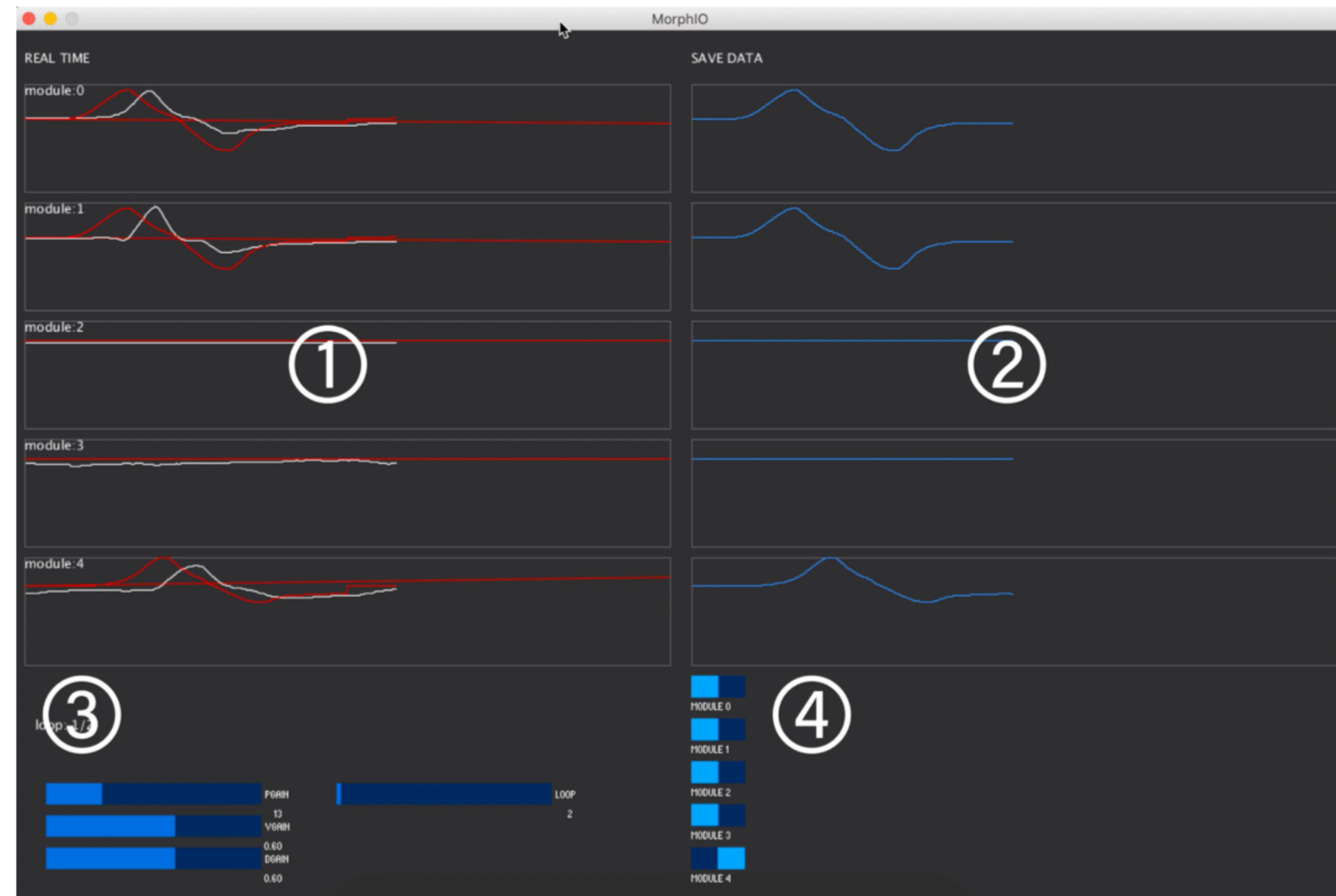


Software System







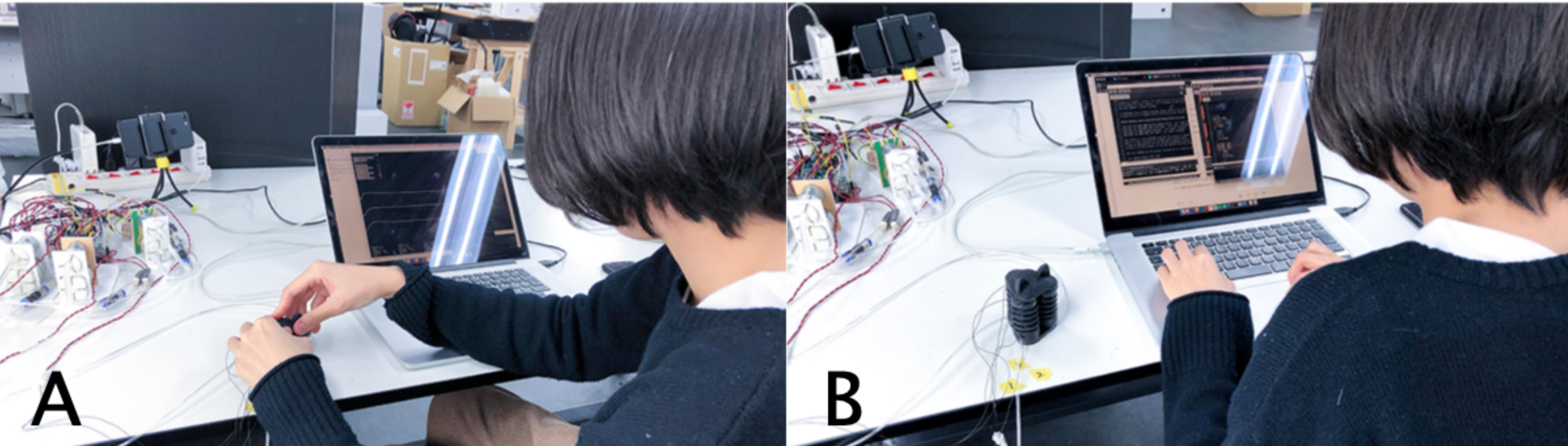


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2. Related Work
3. MorphIO: System and Implementation

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Control Experiment



MorphIO

vs

Arduino IDE

Task



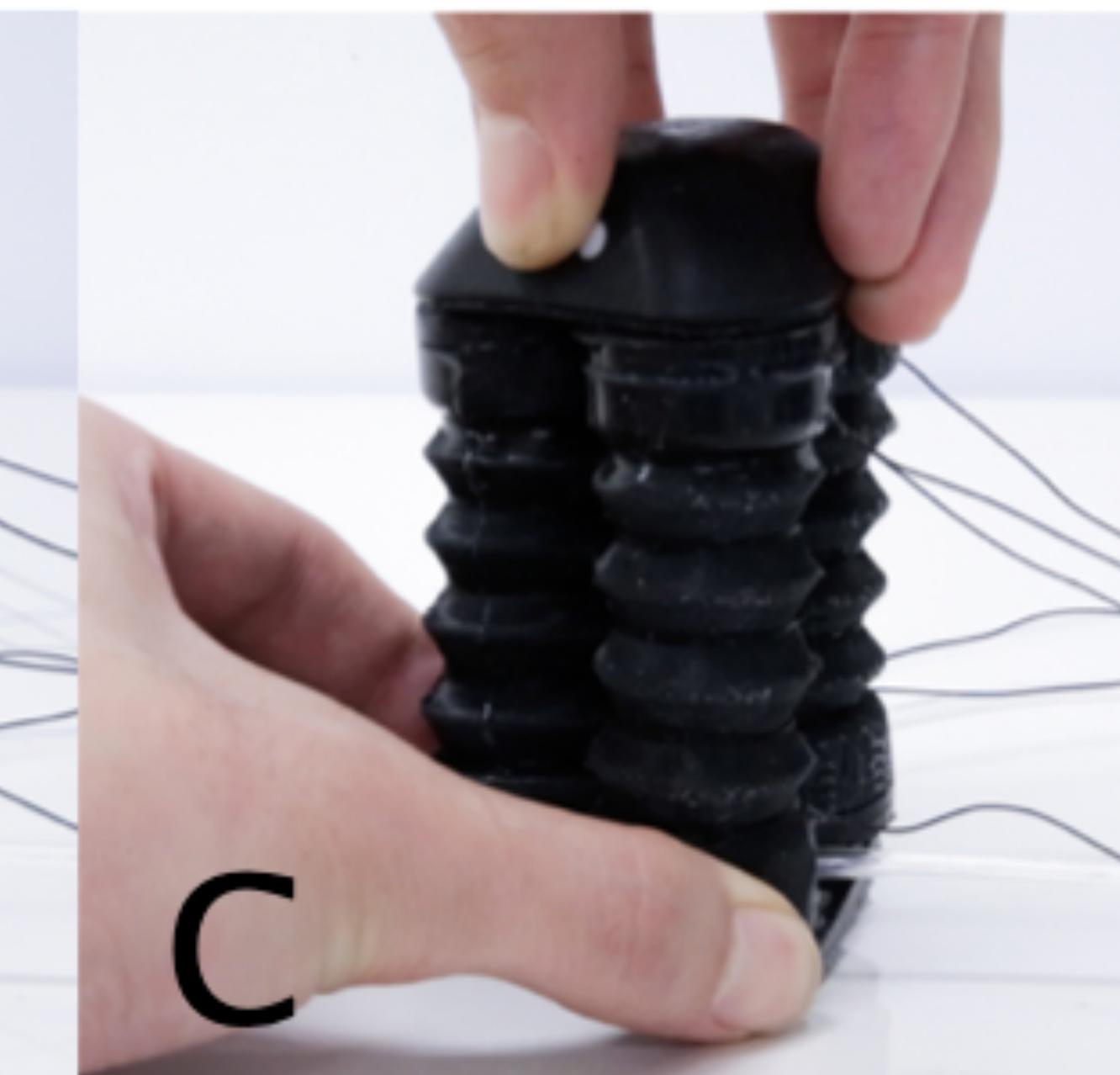
A

happy

B



angry



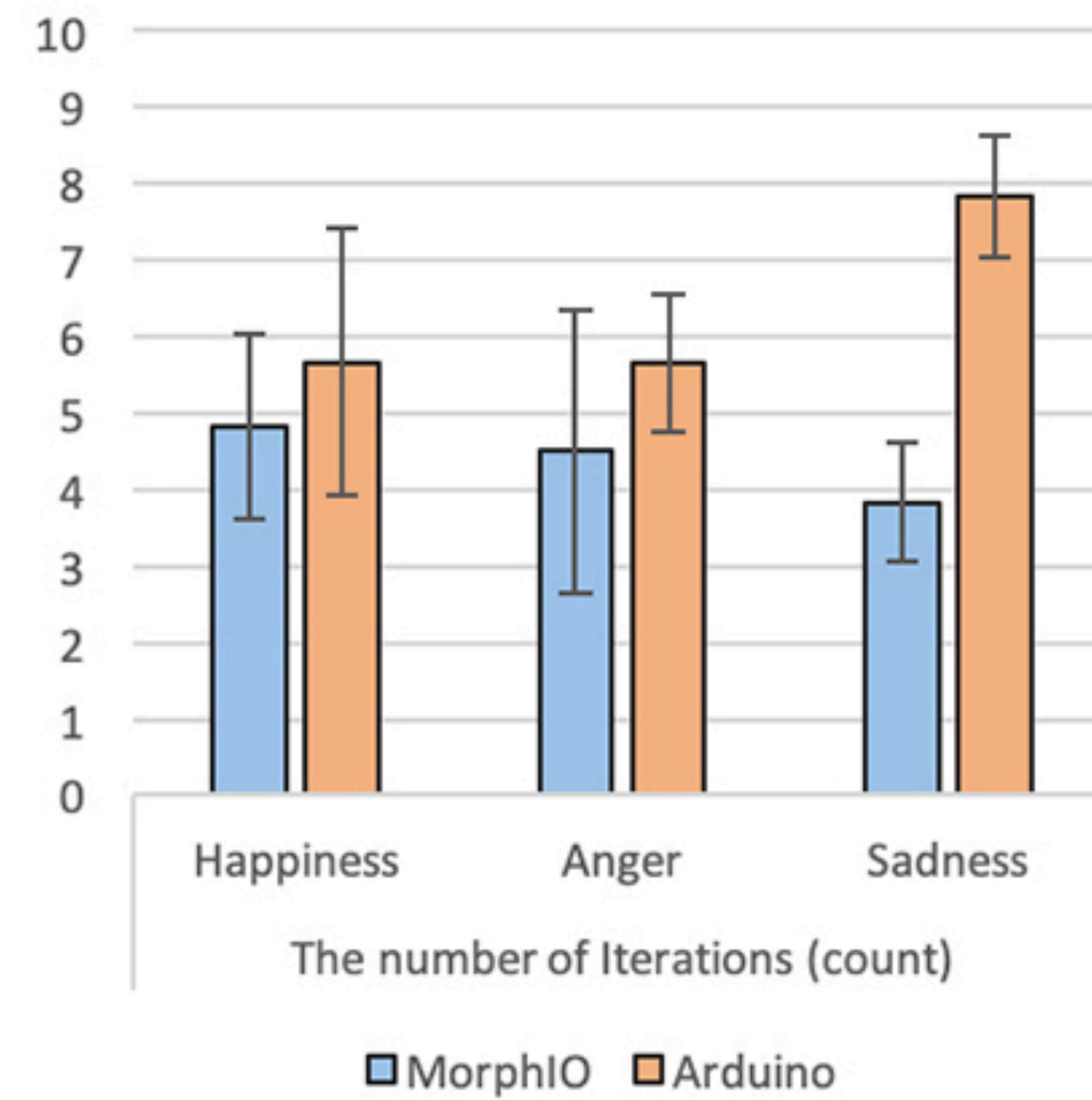
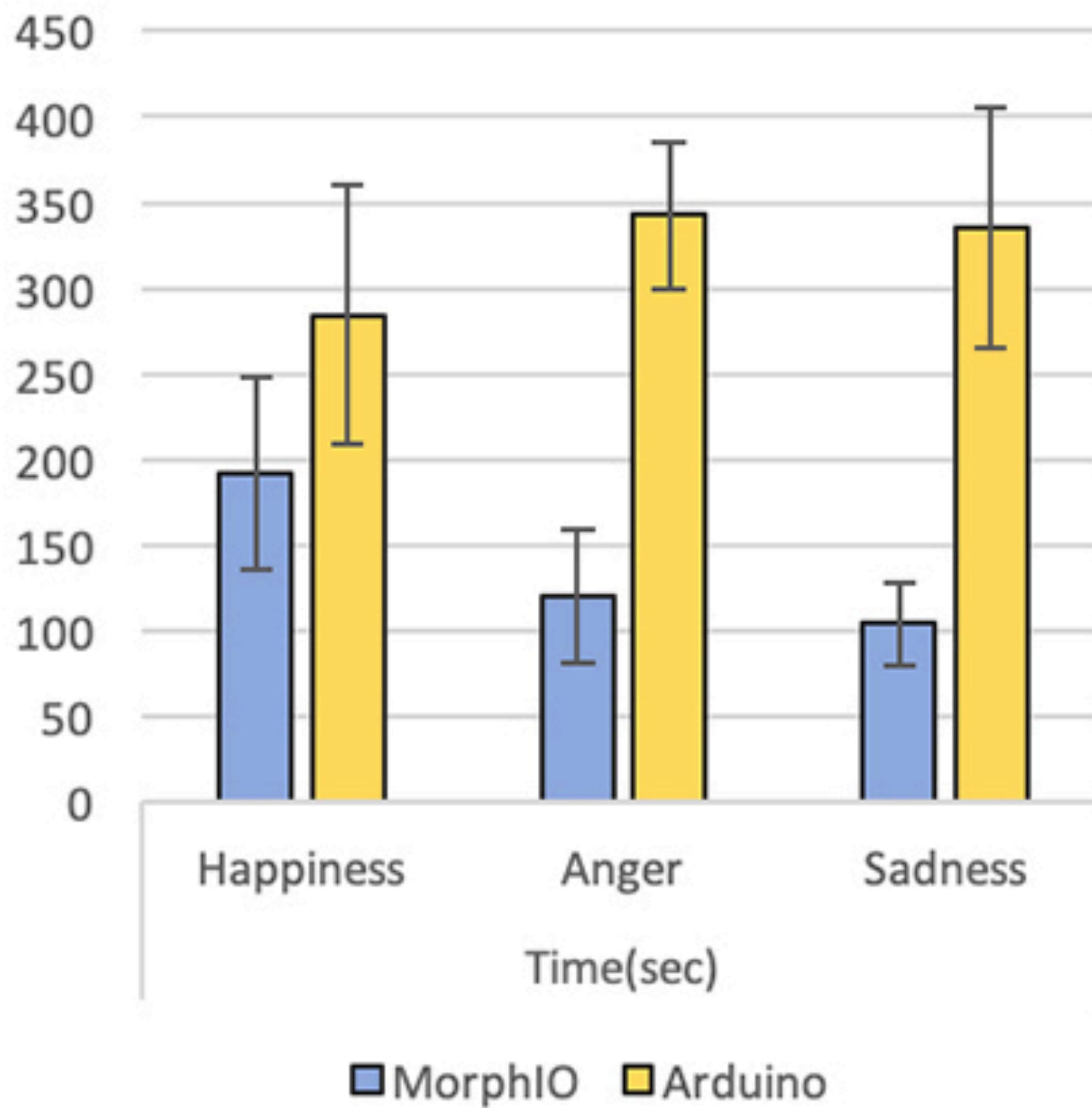
C

sad



RQ1: Does MorphIO save **time** and reduce **the number of iterations** to program the target behavior, compared to the existing approach?

RQ2: Does MorphIO increase the **expressiveness** of the motion?



RQ1: Does MorphIO save **time** and reduce **the number of iterations** to program the target behavior, compared to the existing approach? → **Yes**

RQ2: Does MorphIO increase the **expressiveness** of the motion? → **No**

Insights

tangible interactions are suitable for sculpting
rough motion,

on the other hand...

programming allows for fine-tuning more precise
adjustments.

Future Research Question

How can we leverage the both benefits?

e.g.

drawing: rough sketch → detail

programming: rough motion → detail

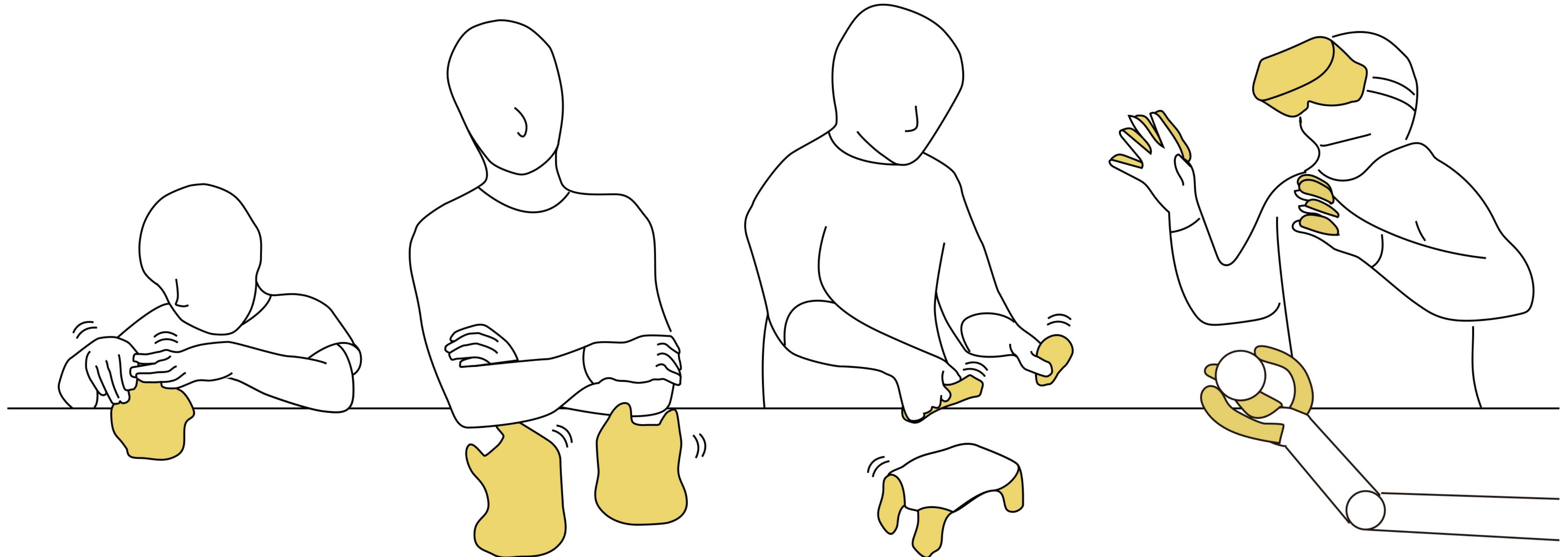
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Contributions

1. **Entirely soft** sensing and actuation unit
2. **MorphIO**, programming by demonstration environment
3. **Applications** and user **evaluation**

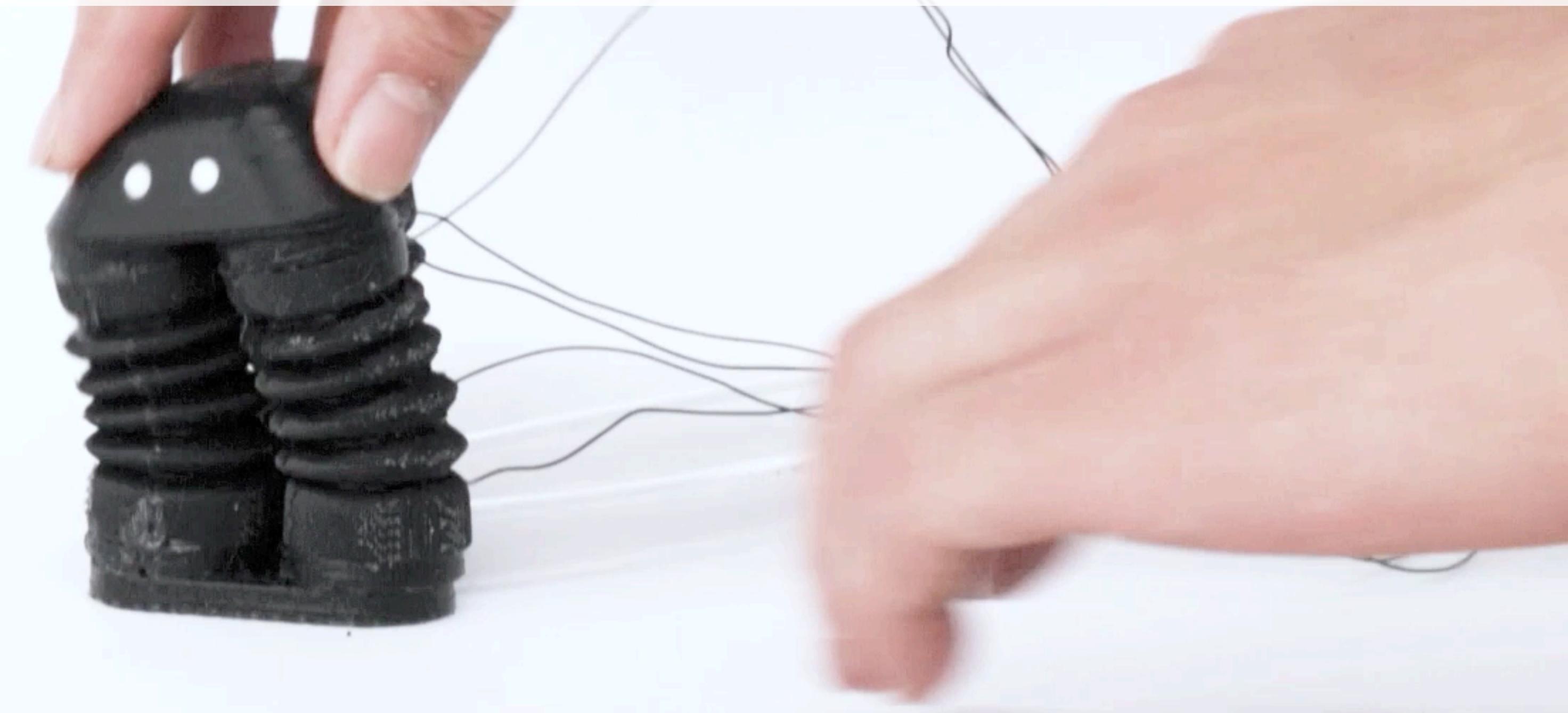
Future Vision



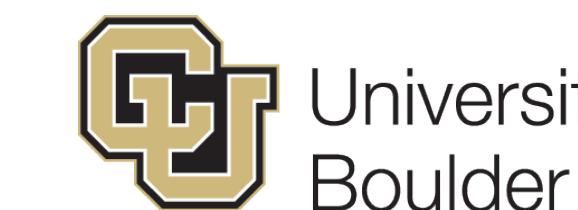
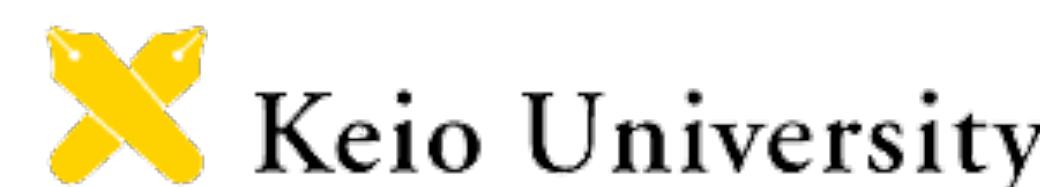
Sculpting behaviors like clay

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