

Beyond the Touchscreen

**Embedded interactivity for a
naturally intelligent environment**

Munehiko Sato | MIT Media Lab | The University of Tokyo

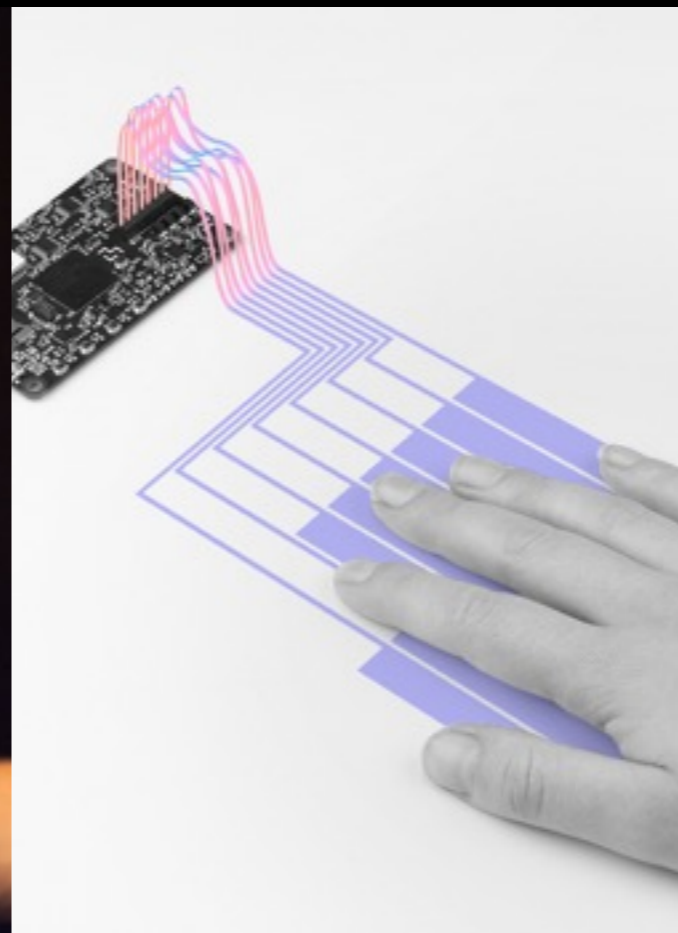




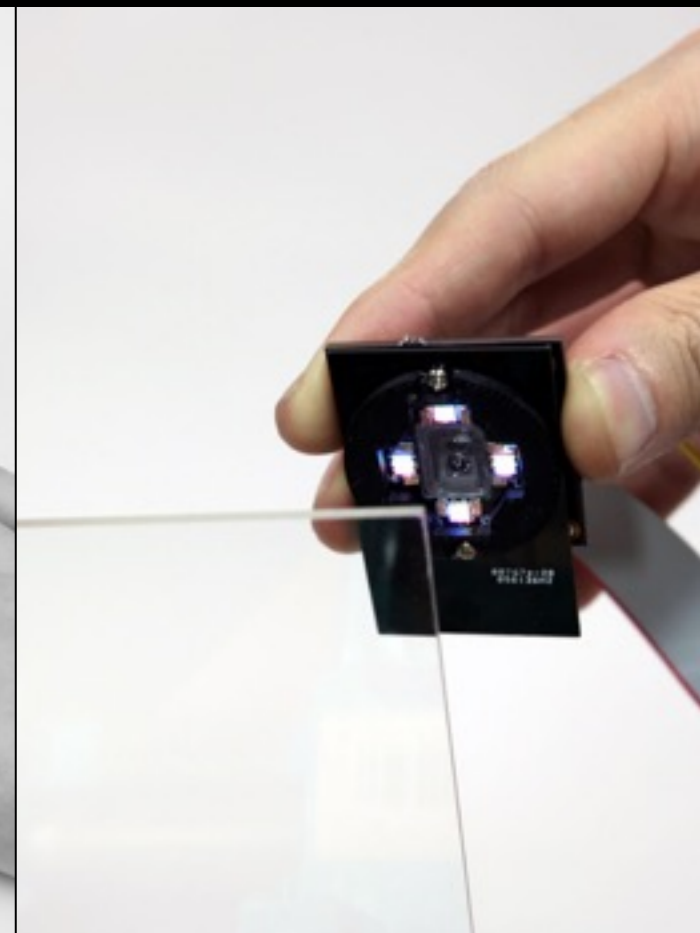
Making ordinary
objects
gesture interactive



Making plants touch
interactive



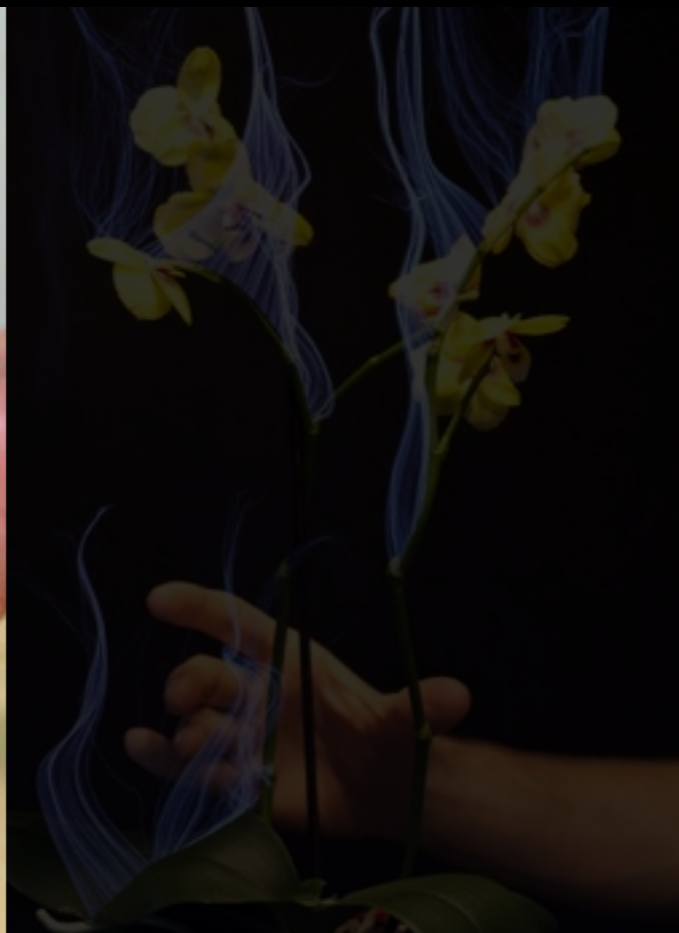
Effortless user
recognition through
bioimpedance



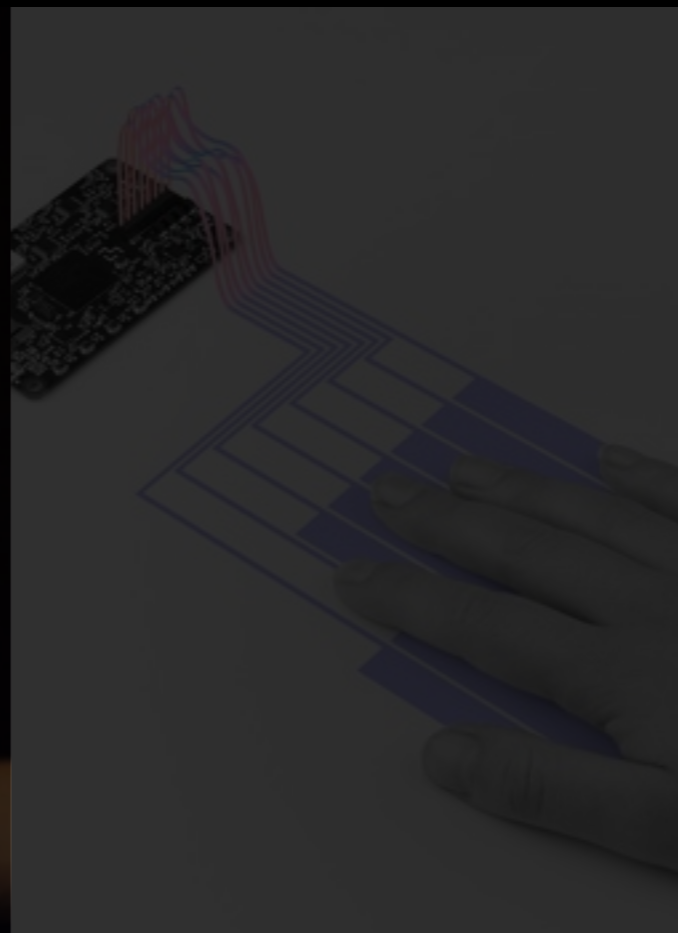
Recognizing
transparent surfaces



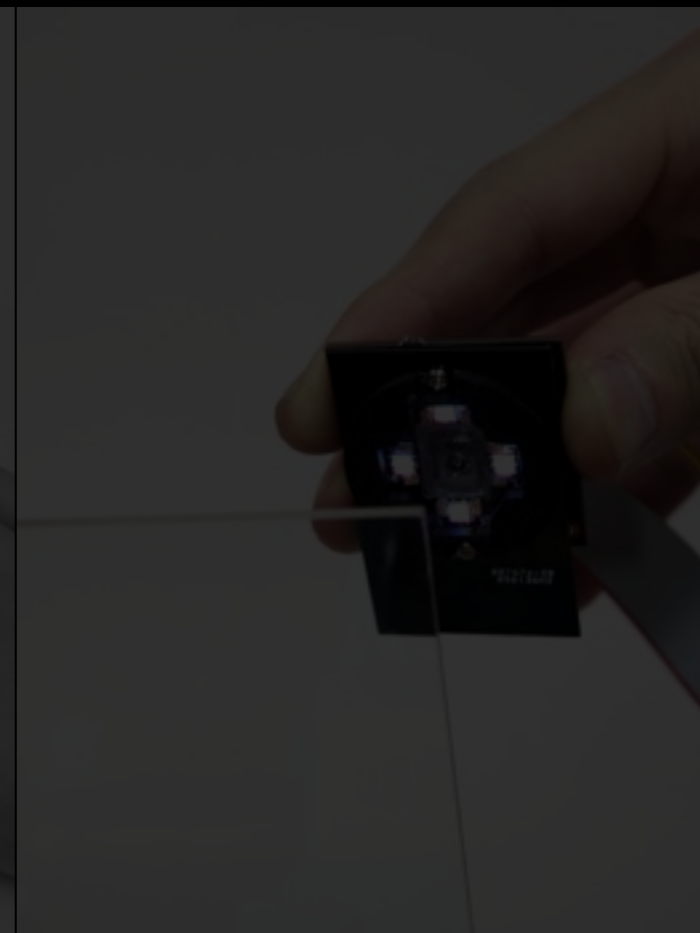
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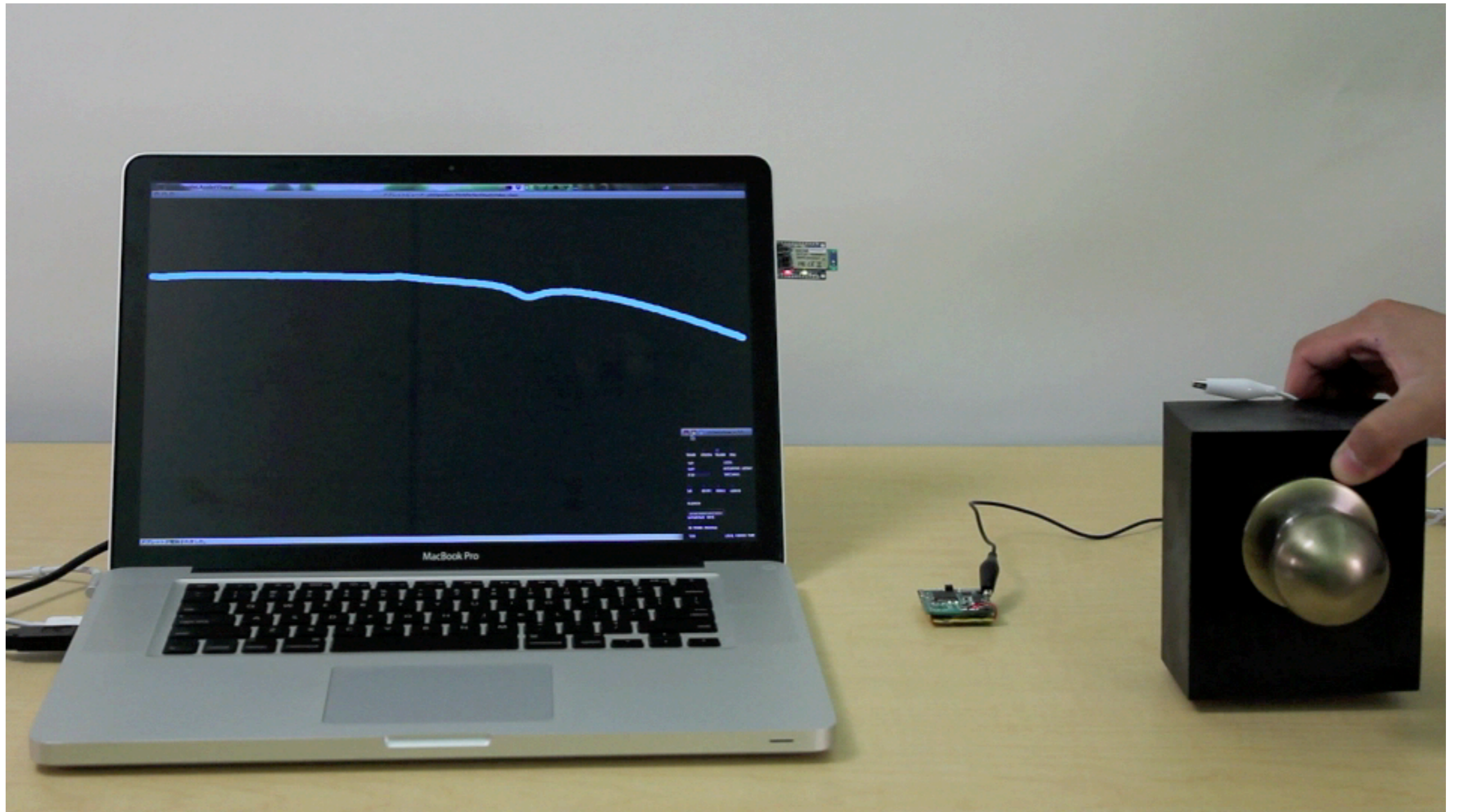


Recognizing
transparent surfaces

Touché

Enhanced touch interaction for
everyday objects

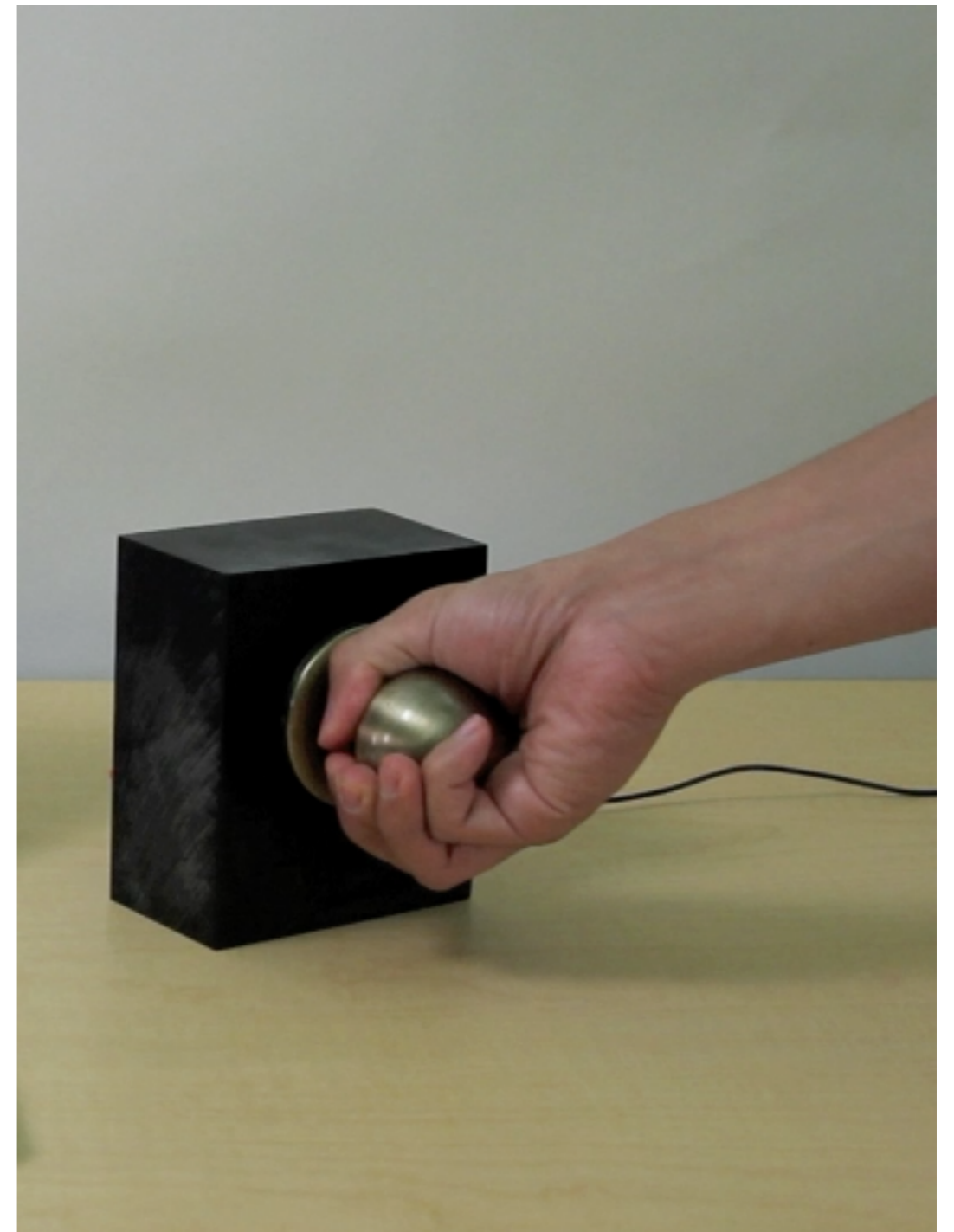




Touché sensor

Benefits

- **Invisible**
- Easy **instrumentation**
- **Expressive**: supports a wide variety of gestures
- **Scalable**: can be applied to any object without customisation



Touché sensor

The technology behind it:

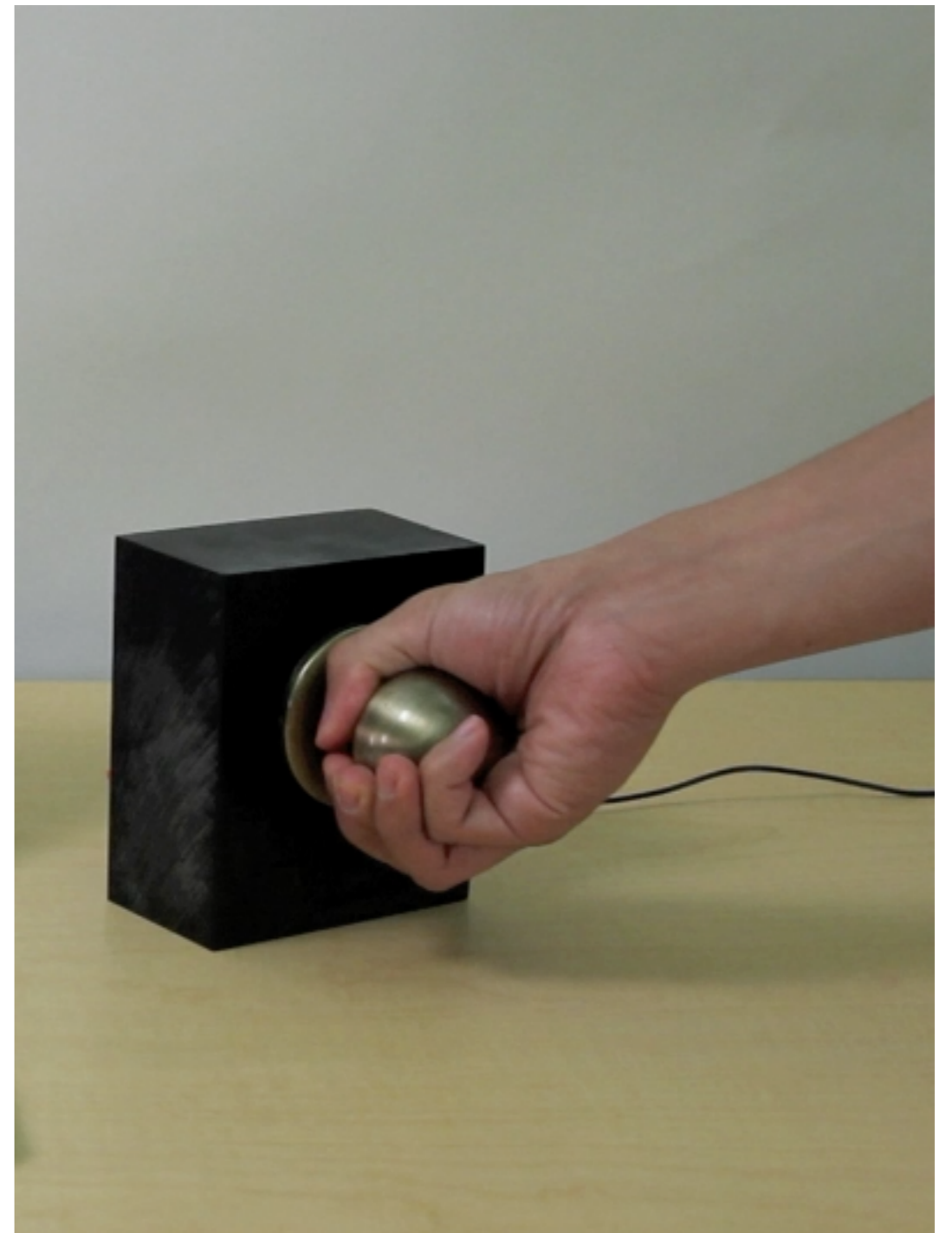
SFCS

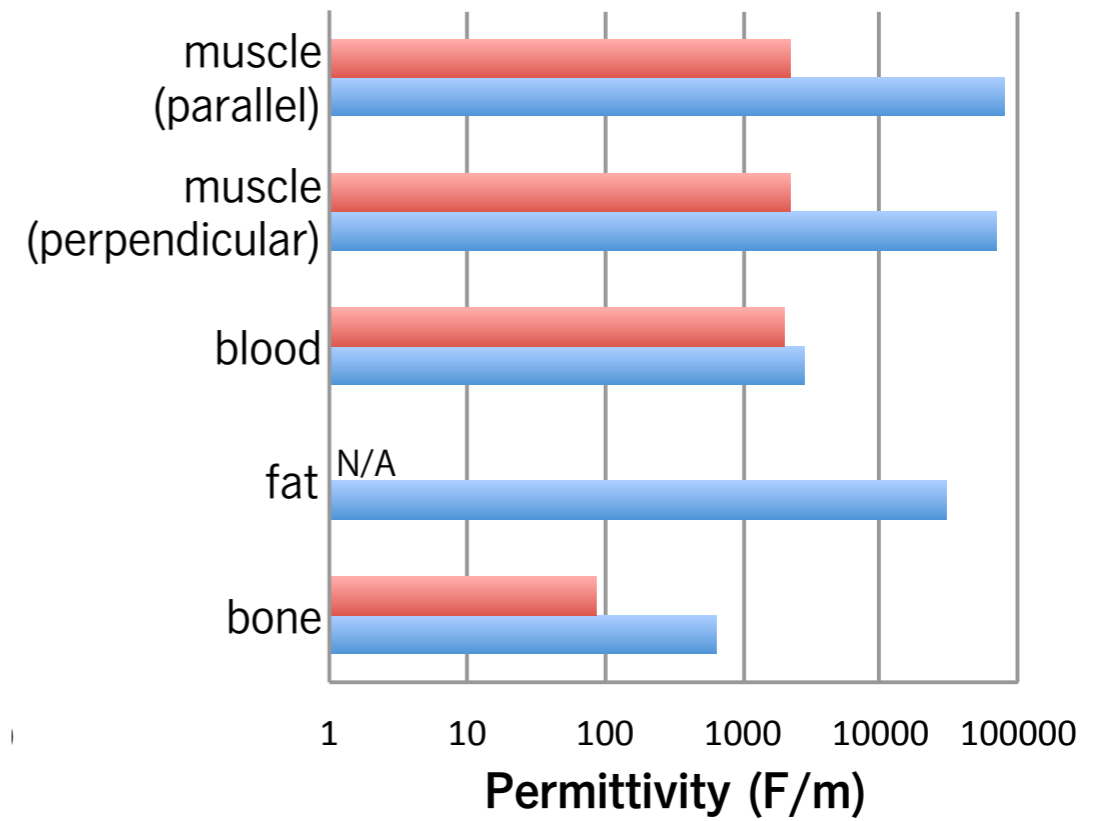
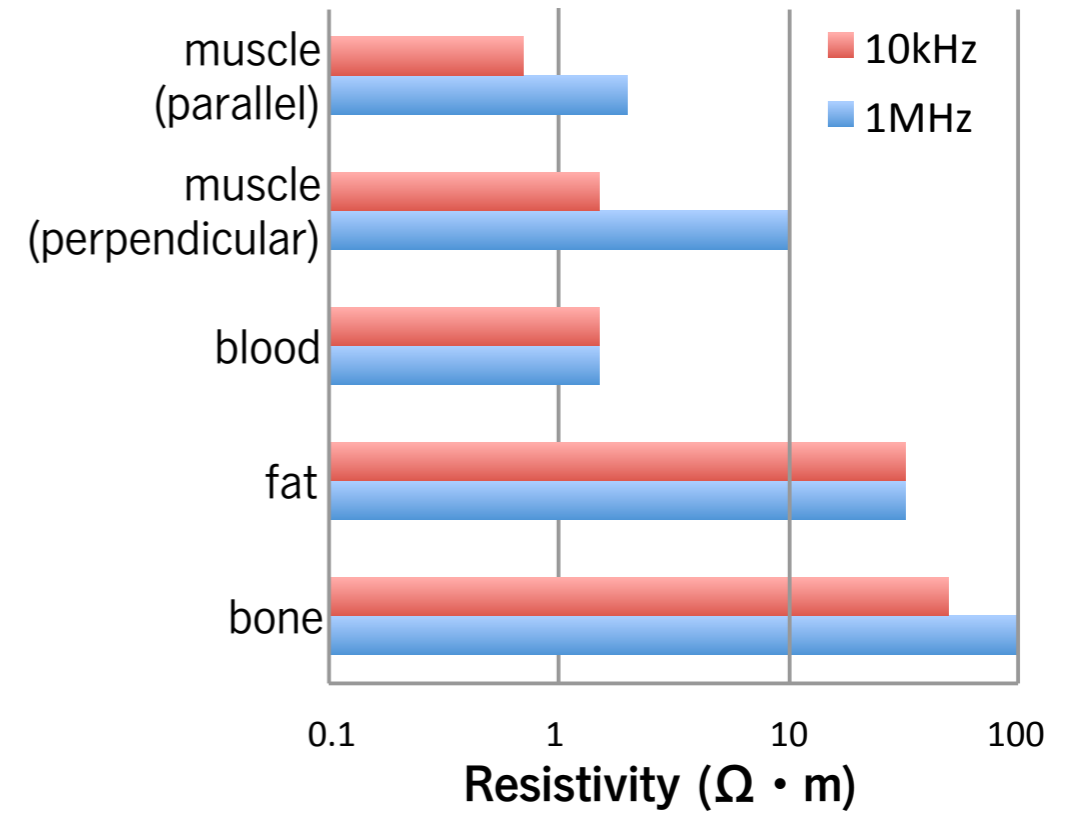
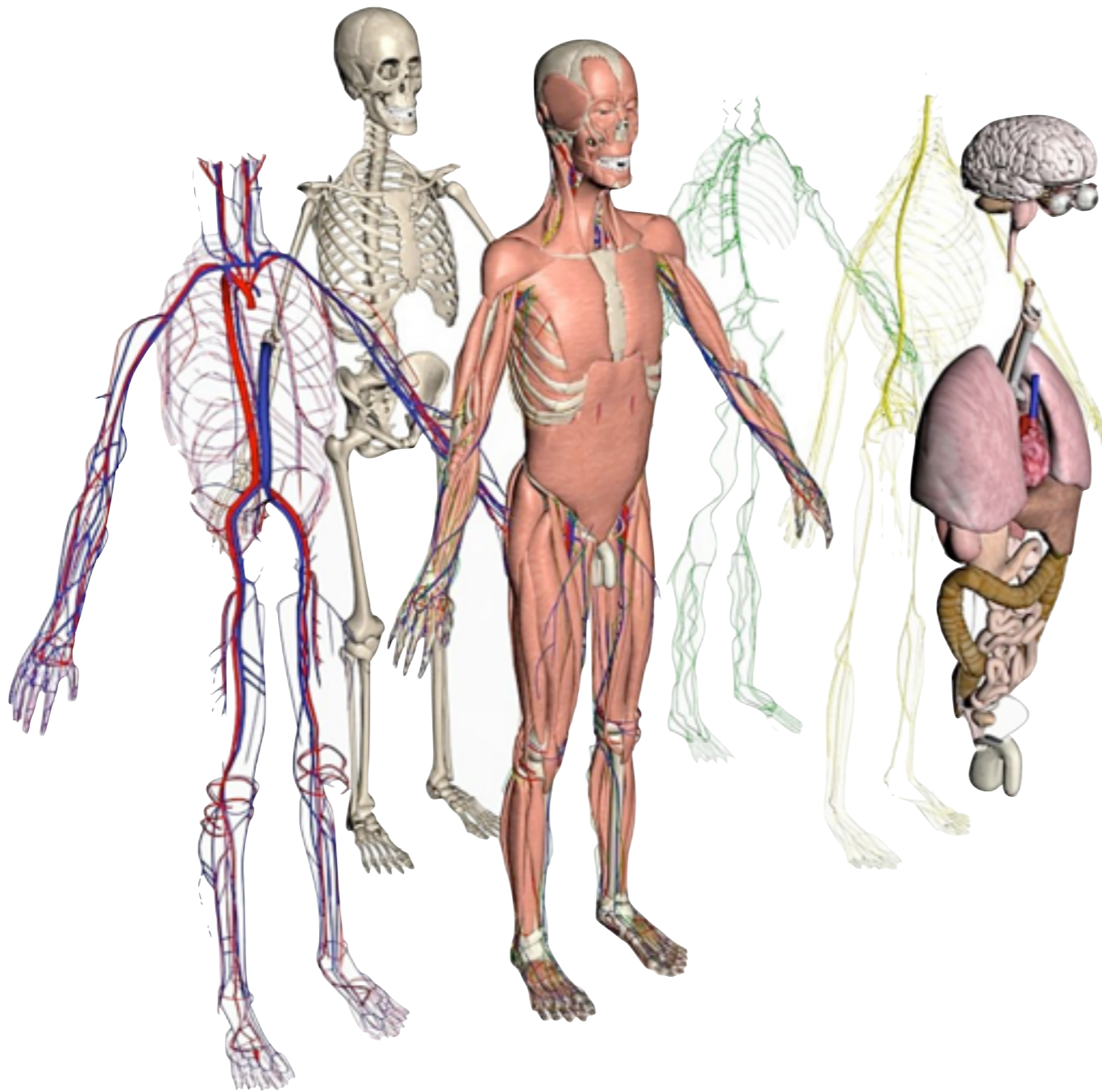
Swept

Frequency

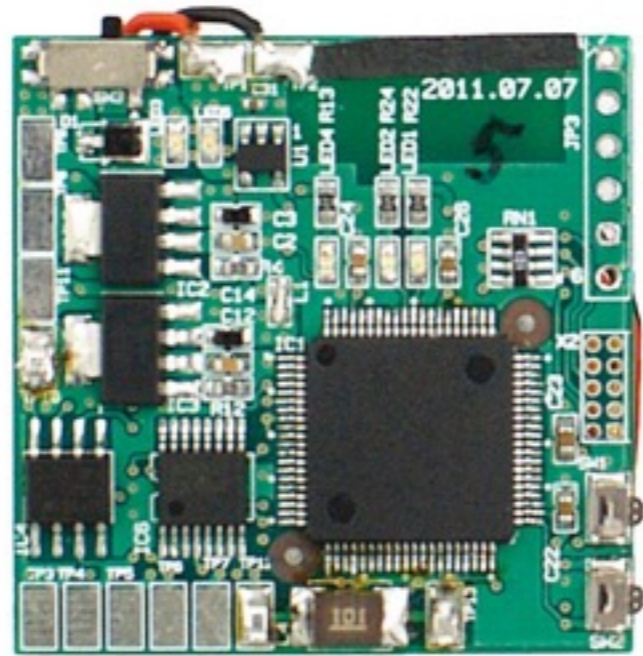
Capacitive

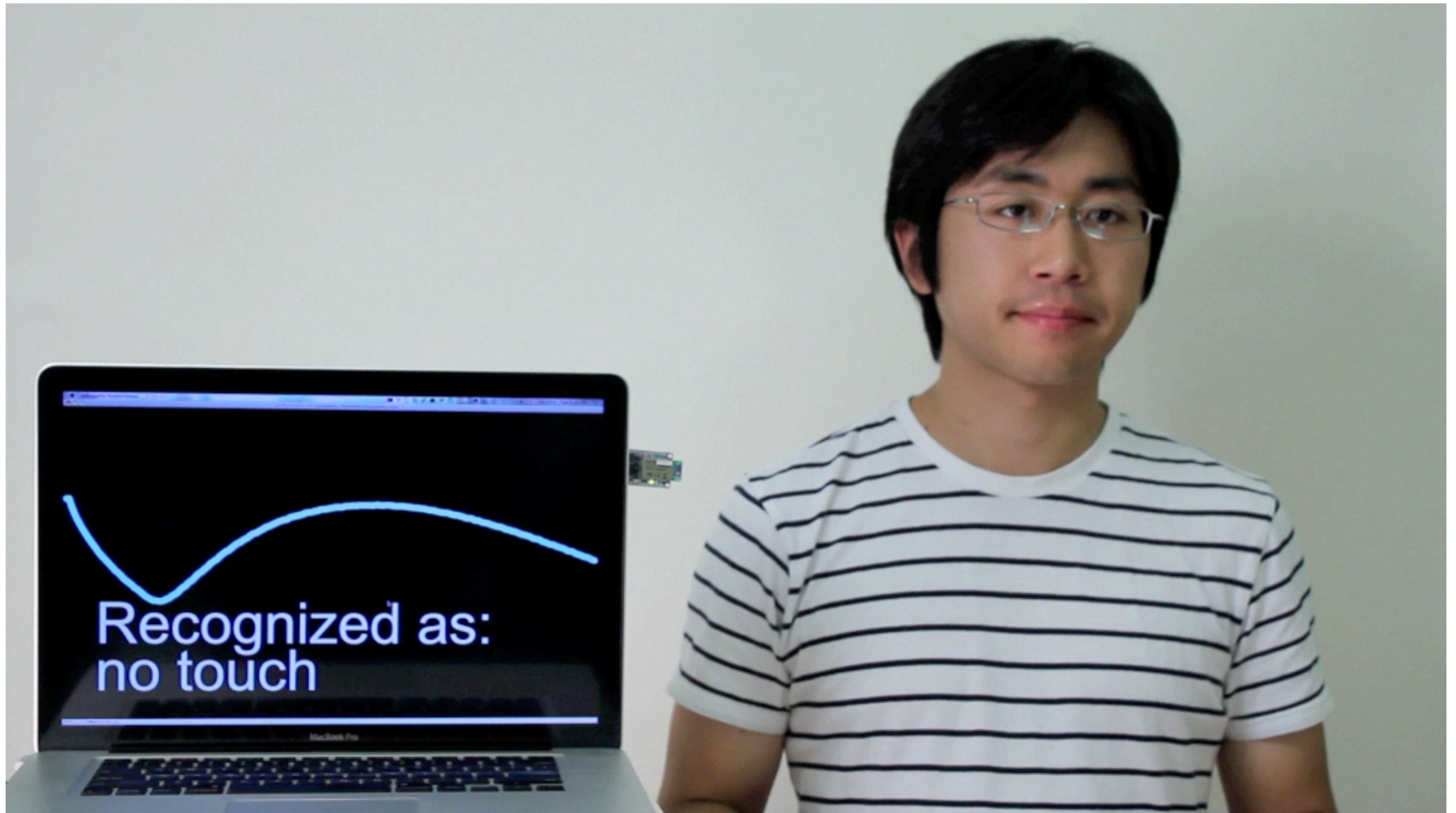
Sensing





0 1 2 3 4 5 6 7 8 cm







Recognized as:
away





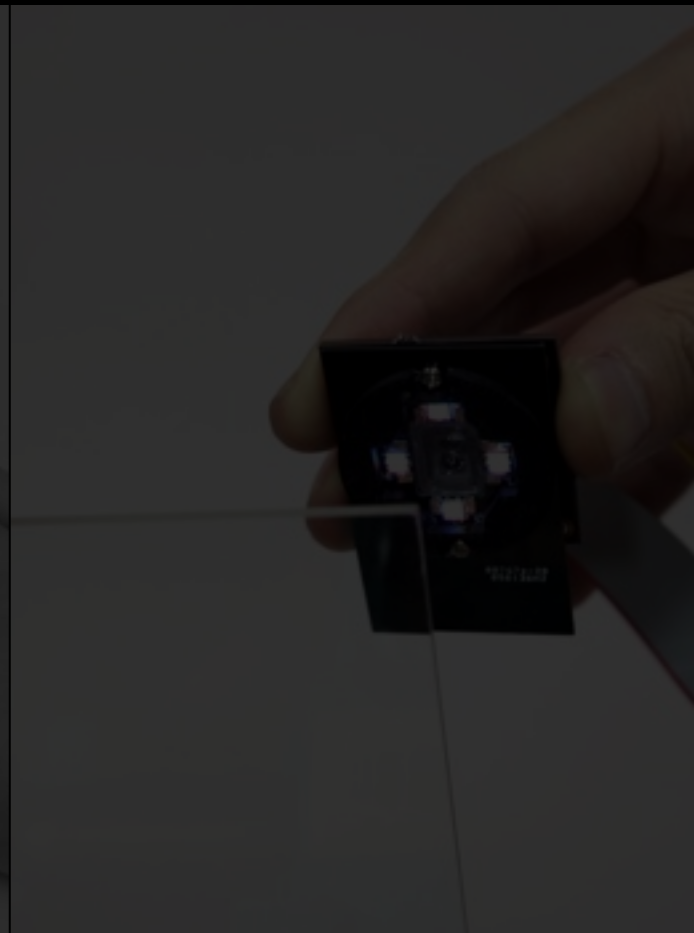
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Effortless user
recognition through
bioimpedance



Recognizing
transparent surfaces



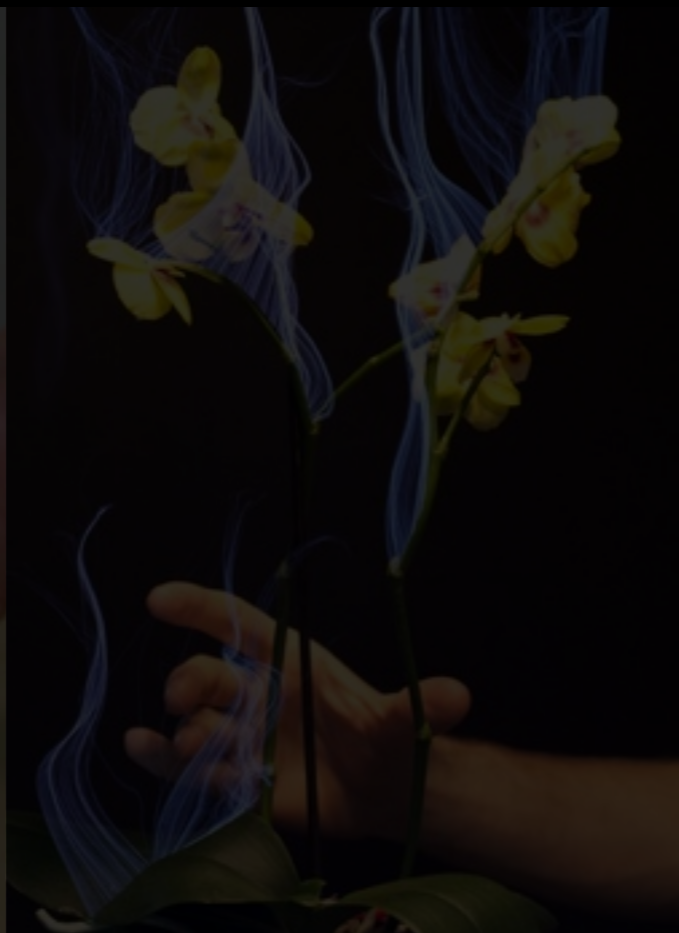
Botanicus Interacticus (2012)

*By Ivan Poupyrev / Disney Research, Studio NAND, TheGreenEyl, Phillip Schöbler, Christian Riekoff
with Munehiko and Eric Brockmeyer*

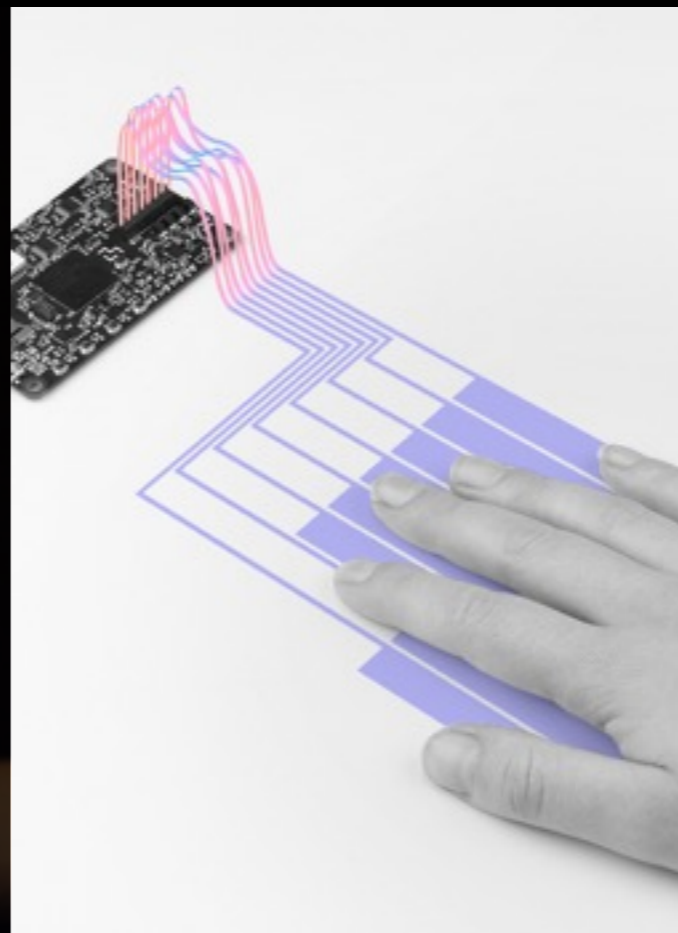




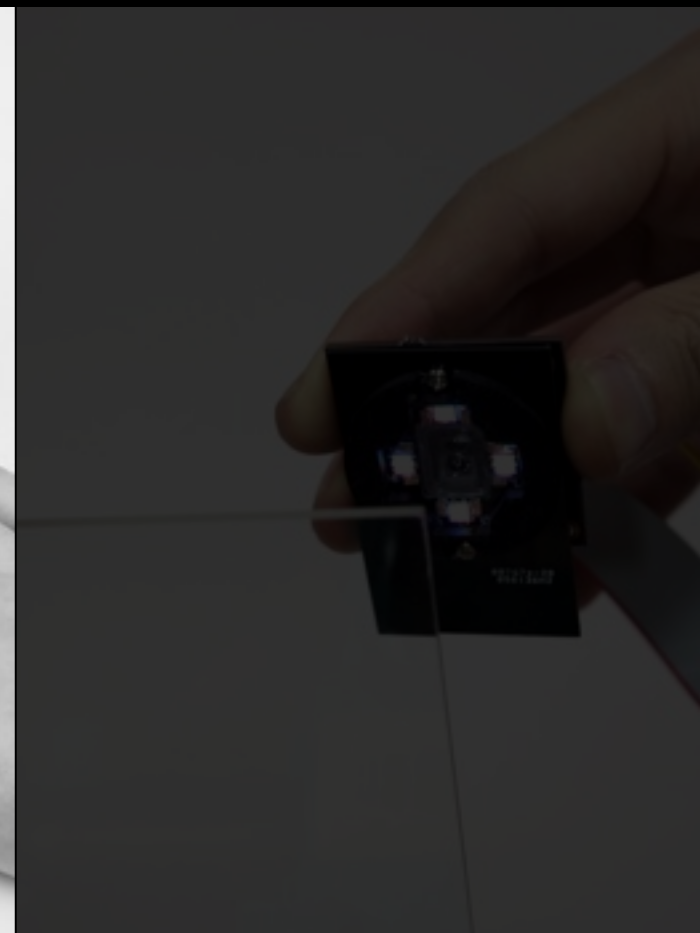
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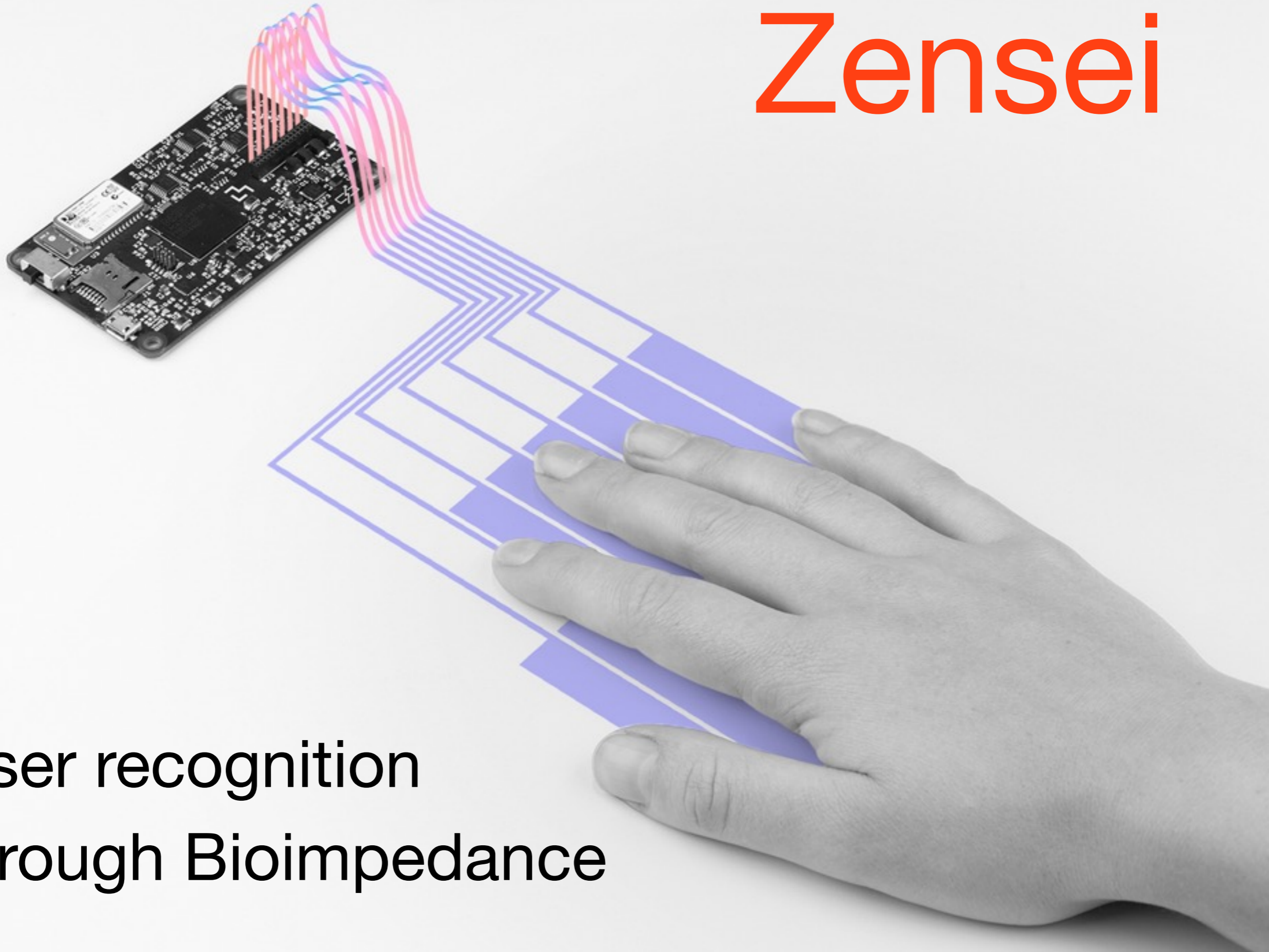


Effortless user
recognition through
bioimpedance

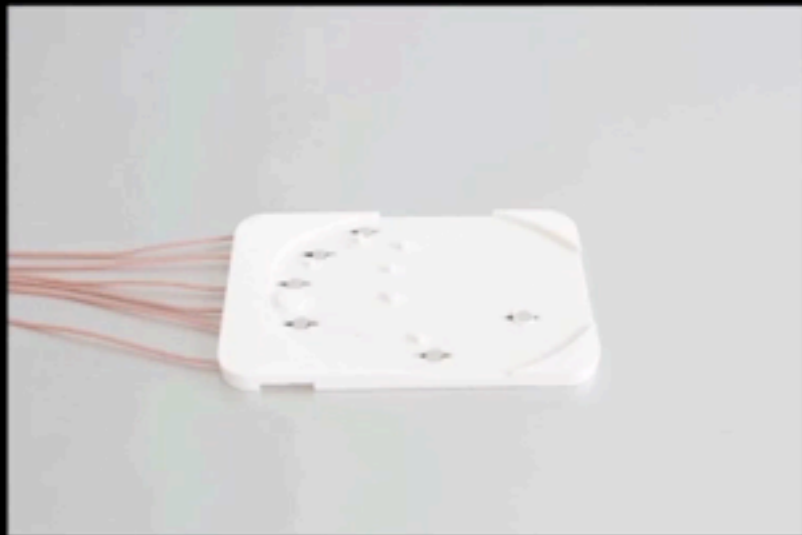


Recognizing
transparent surfaces

Zensei



User recognition
through Bioimpedance



USER 1



BEETHOVEN

USER 2



JANE

USER 3

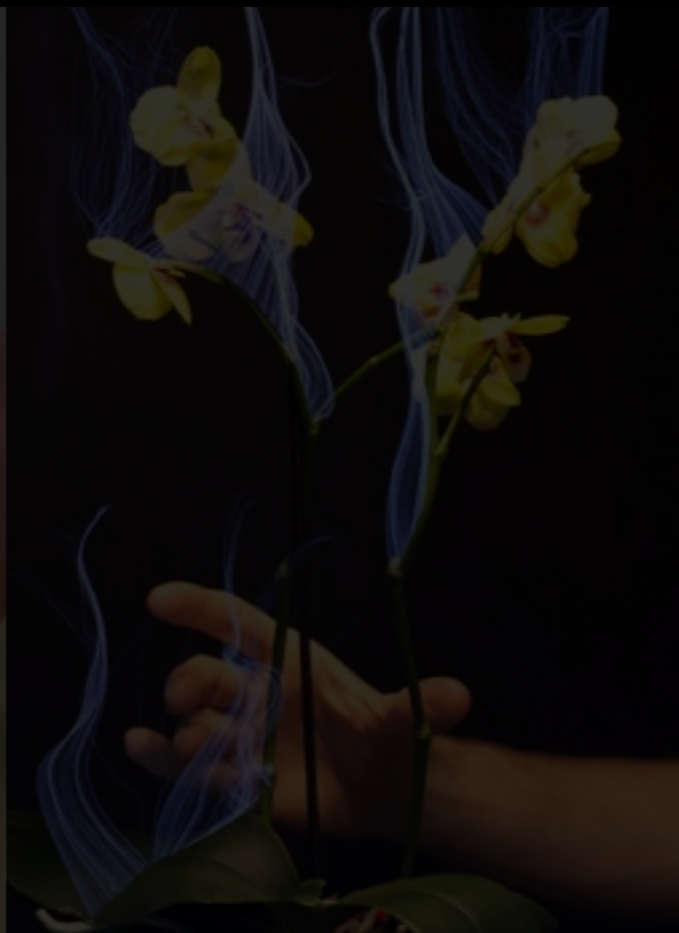


RAPHAEL

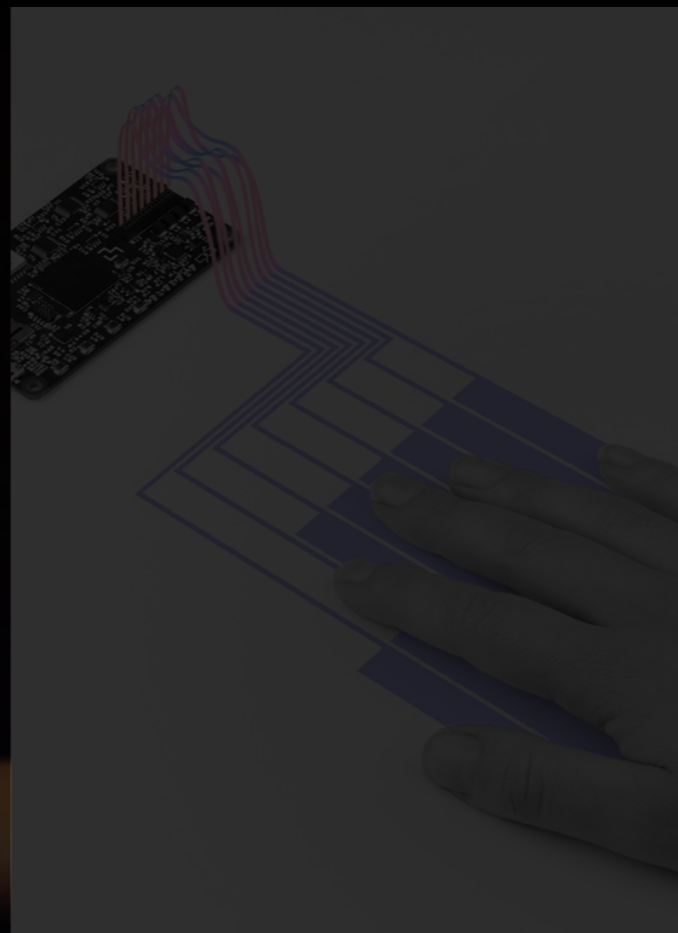




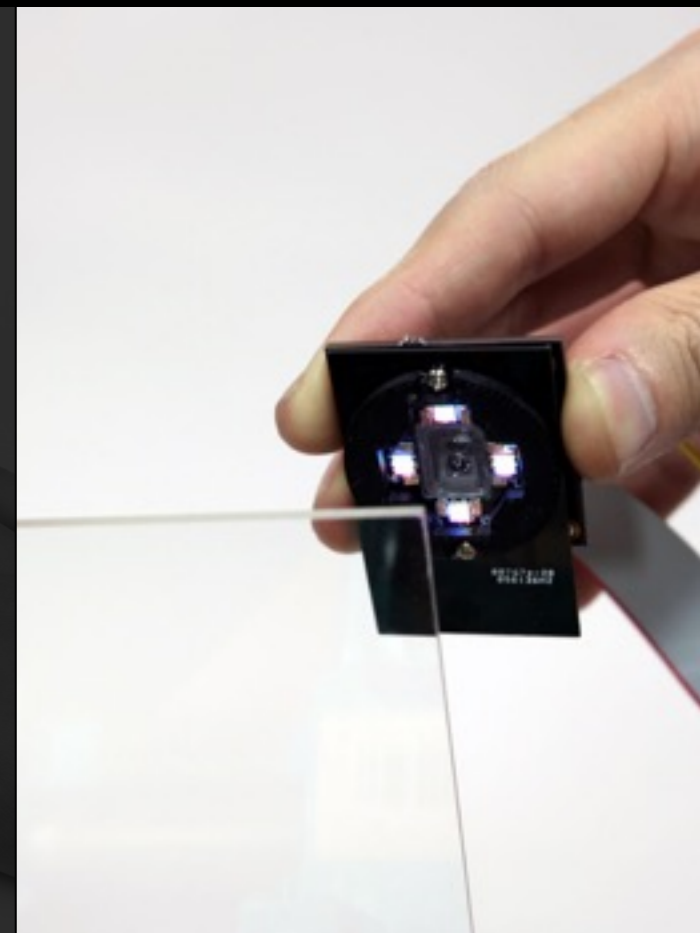
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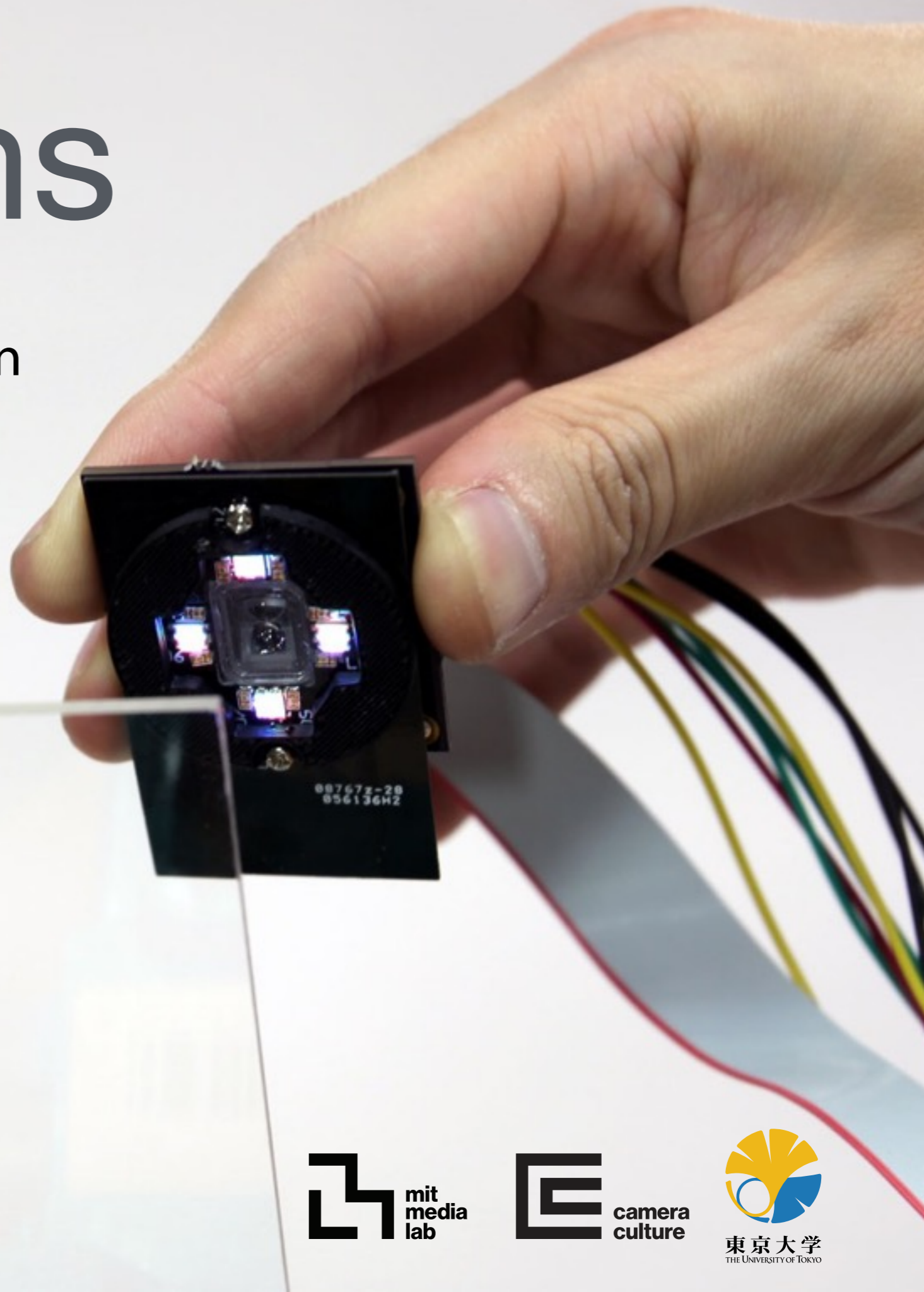
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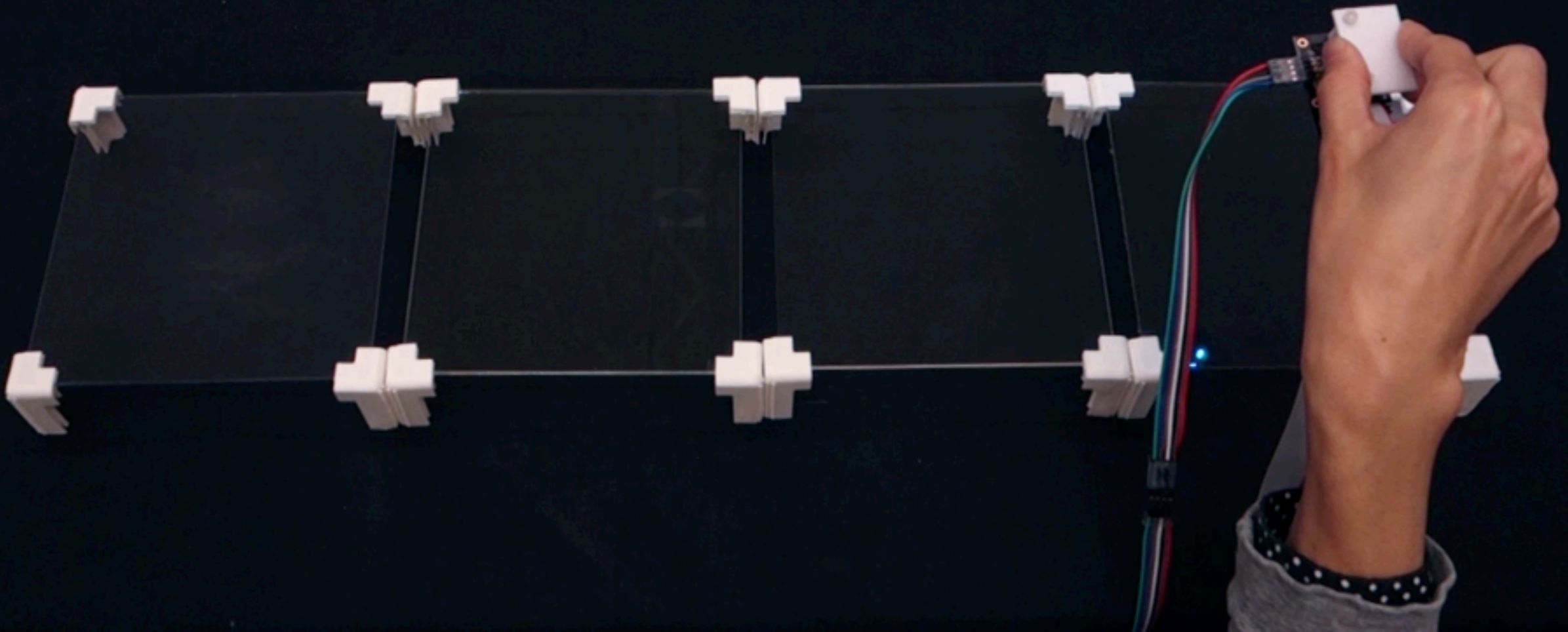


Recognizing
transparent surfaces

SpecTrans

Versatile Material Classification
for Interaction with
Textureless, Specular and
Transparent Surfaces





Limits of Conventional Technologies

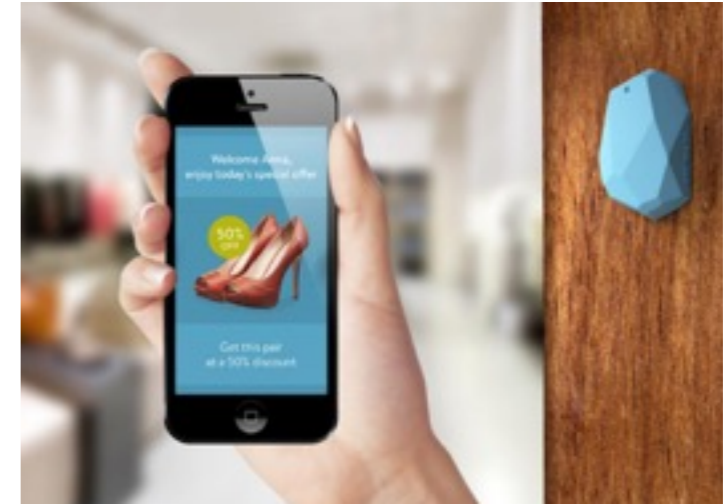
- Mapping digital information to the physical world.



Audio tour with numbers



2D barcodes



iBeacon

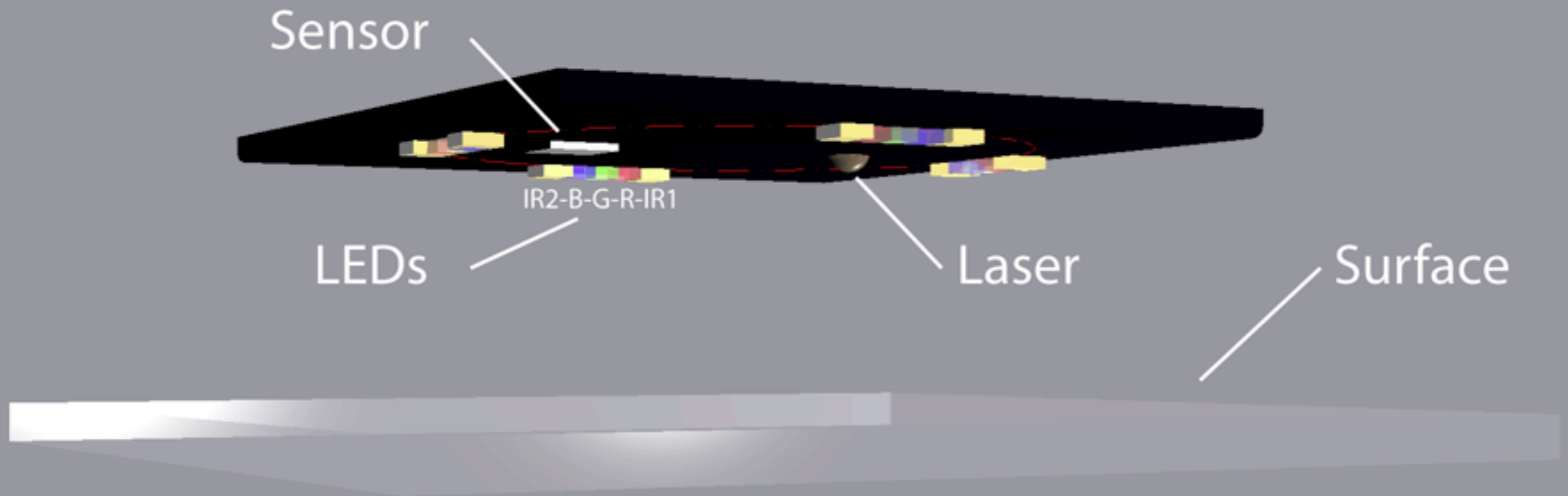
- Image based surface classification usually requires distinct textures.



Image: <http://www.csc.kth.se/~att/Site/Material.html>

Image based Texture Classification

Sparse, high-speed sampling of the BRDF



BRDF: Bidirectional Reflectance Distribution Function

We do not consider Bidirectional Surface Scattering Reflectance Distribution Function (BSSRDF)

4 LED clusters

Laser emitter

Microcontroller

IR LED (850nm)

RGB LED

IR LED (940nm)

Image sensor
(30x30 pixel)



Bluetooth Module



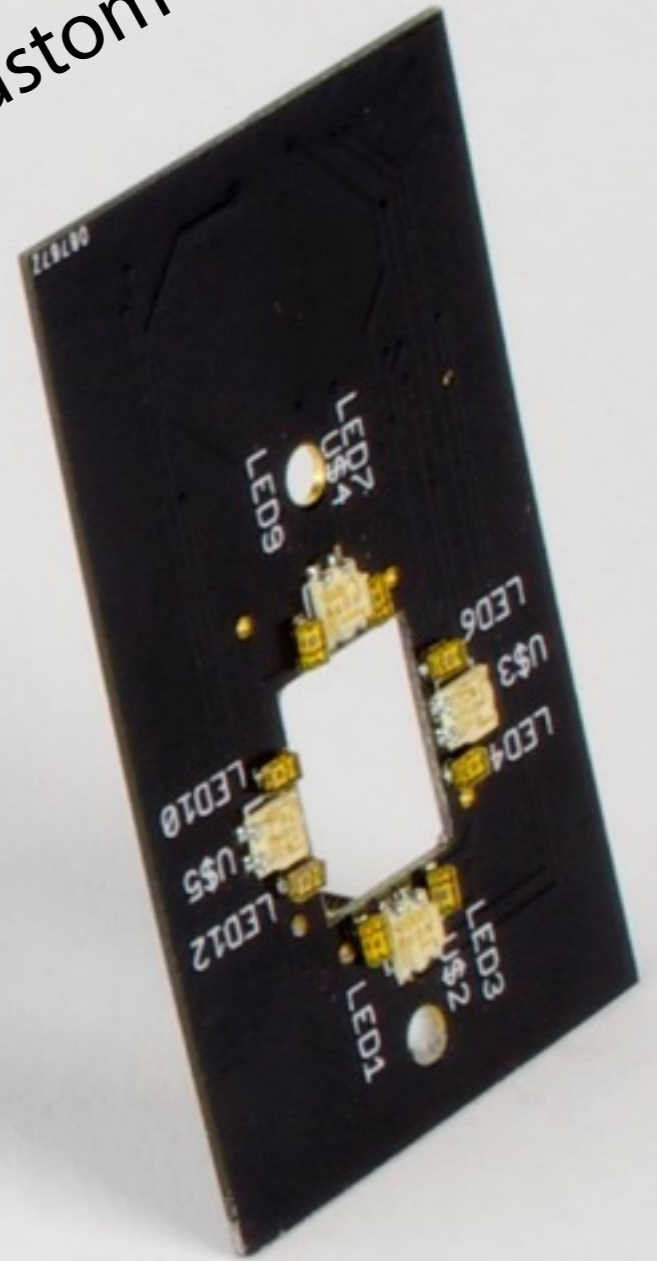
Image sensor
& Laser

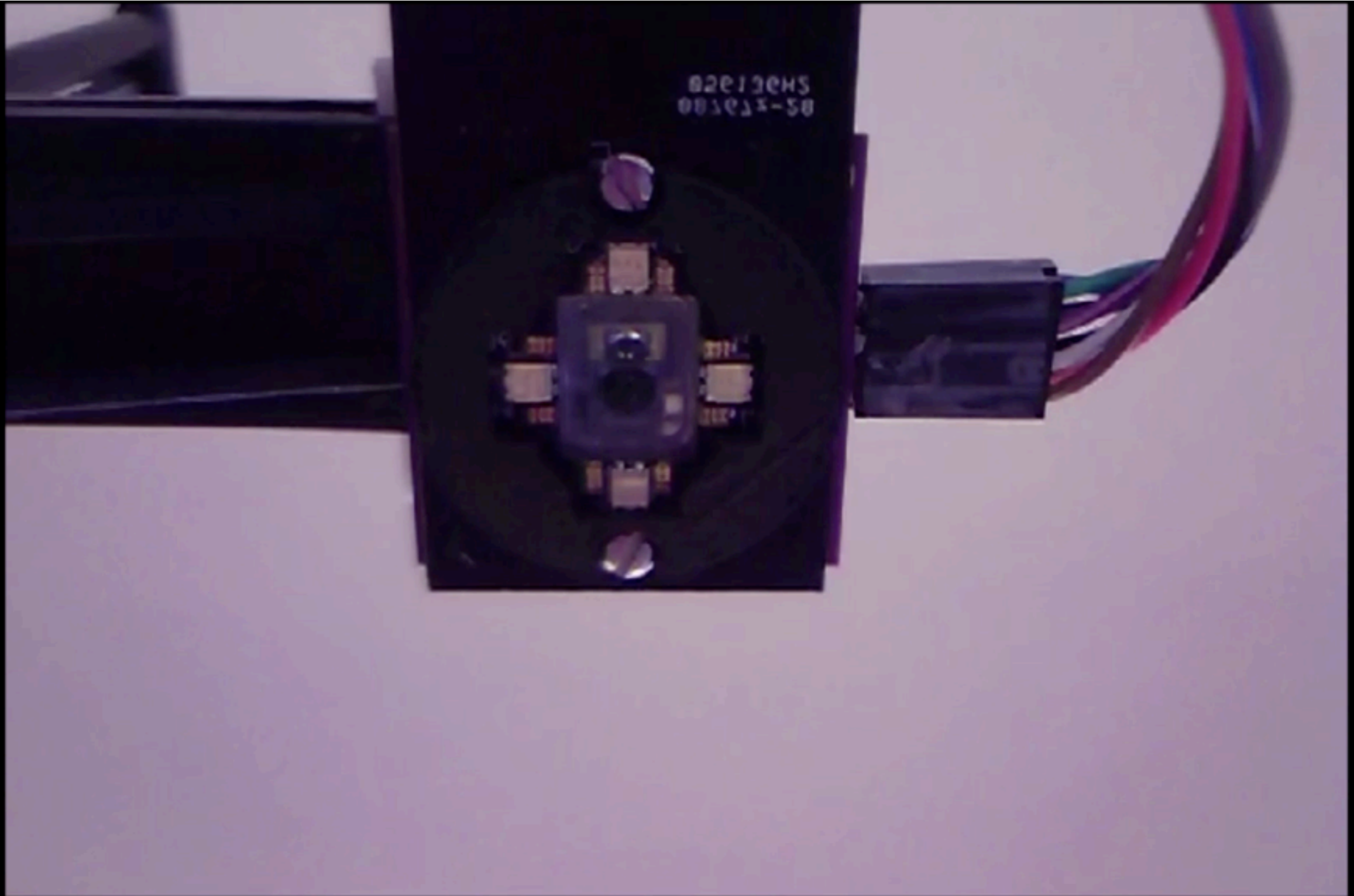


Lens



Custom PCB

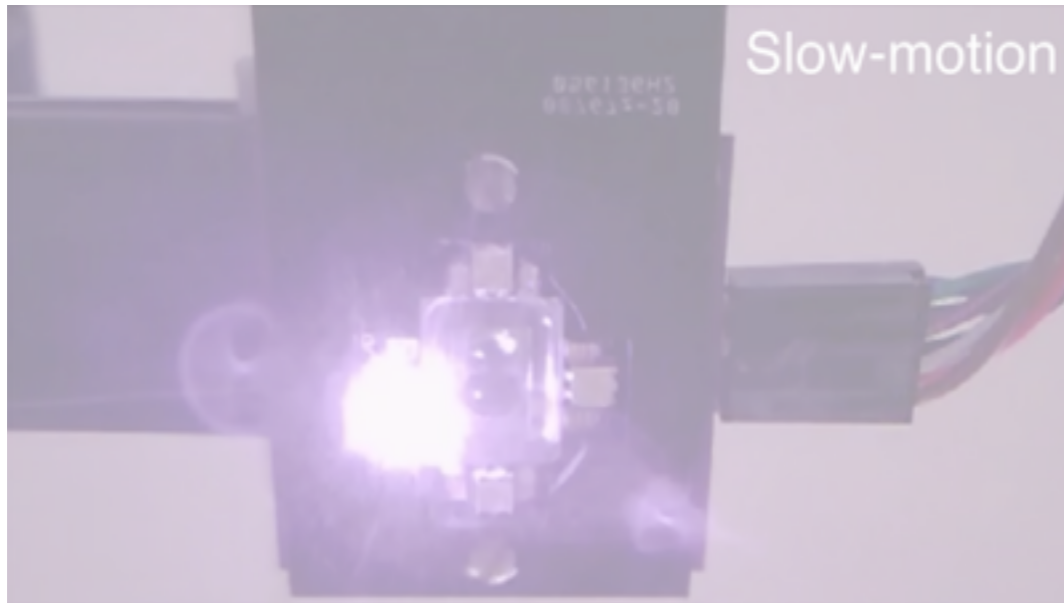




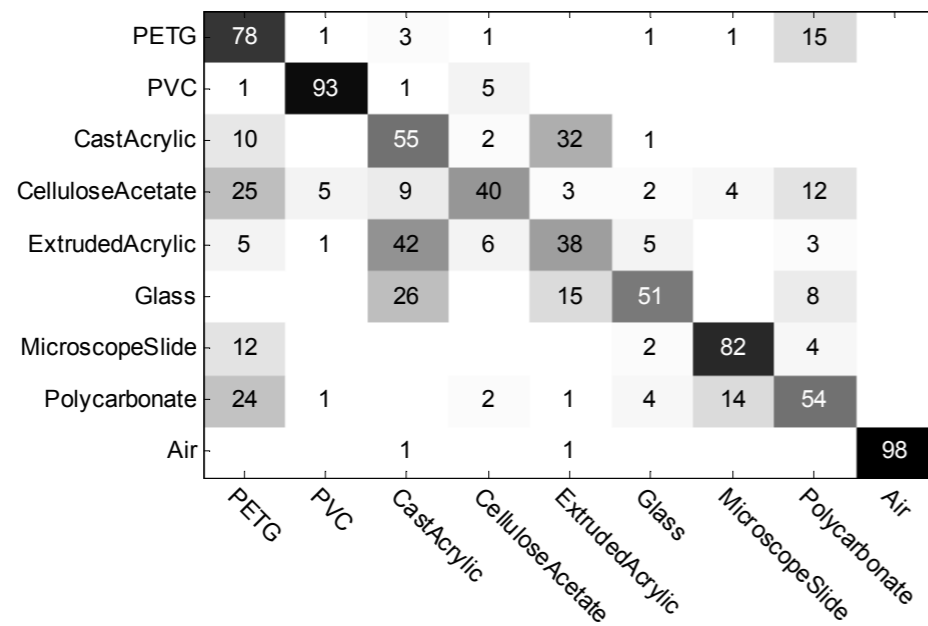
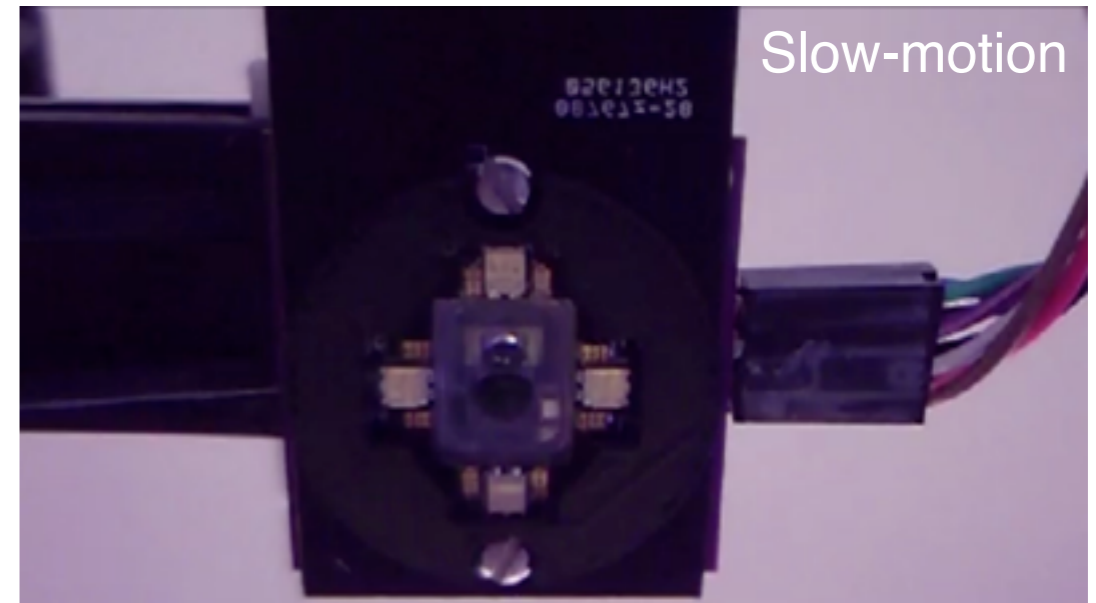
4 surface features x 26 lighting conditions x 4 exposures = 416 samples

High Classification Accuracy with Machine Learning

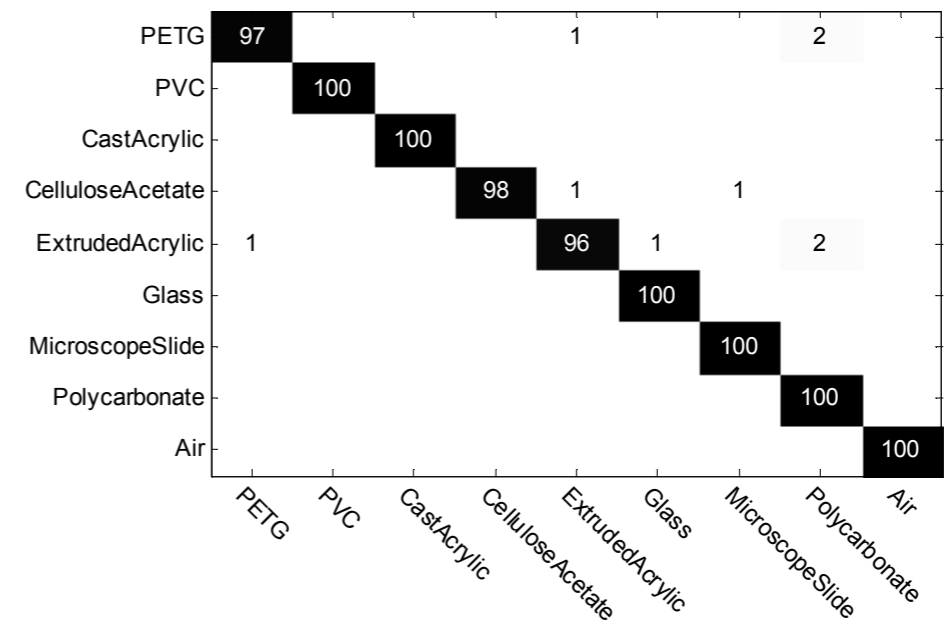
1-directional multi-spectrum LEDs



SpecTrans

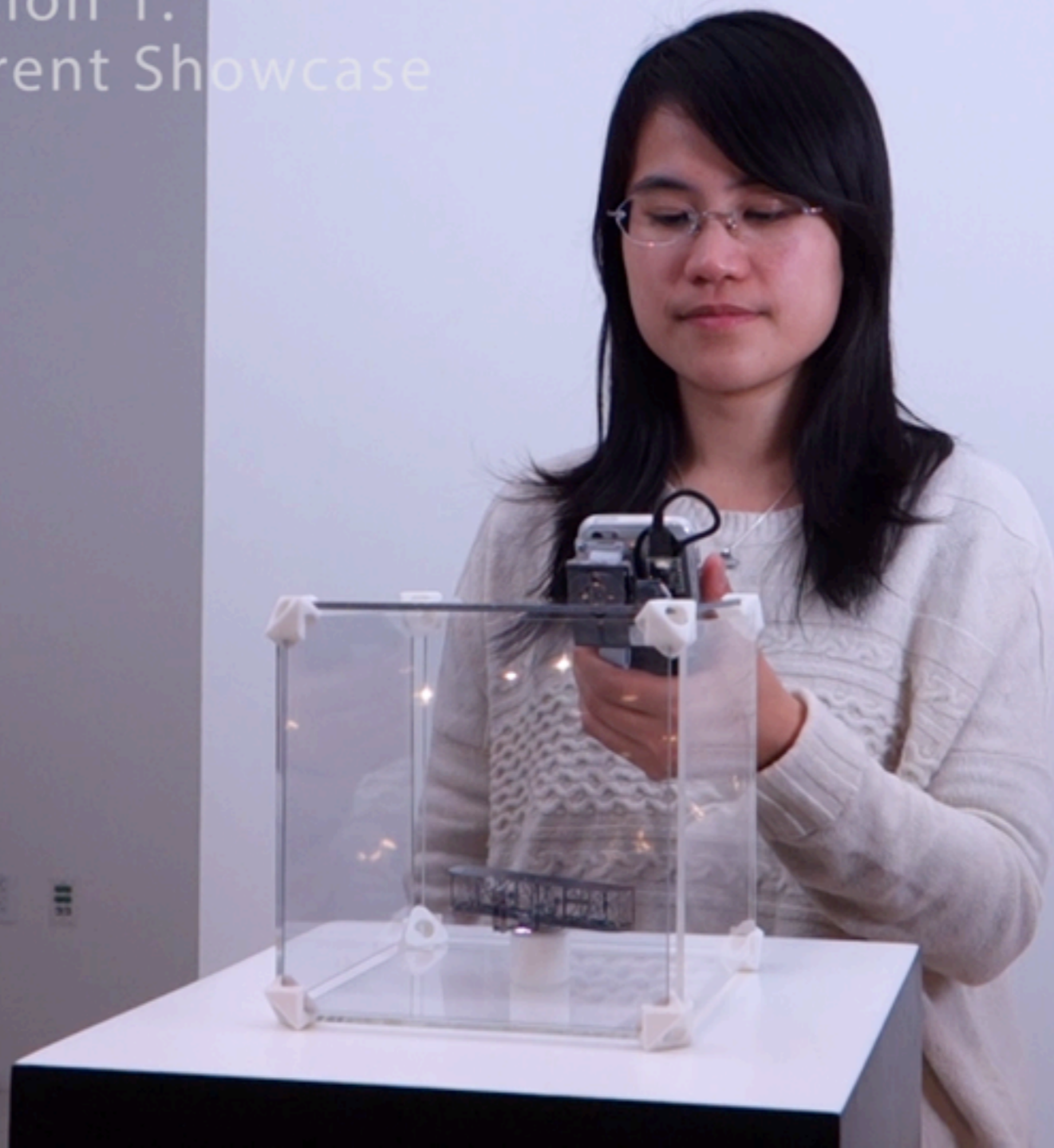


65.4%



99.0%

Application 1: Transparent Showcase



Application 2: Glass Wall



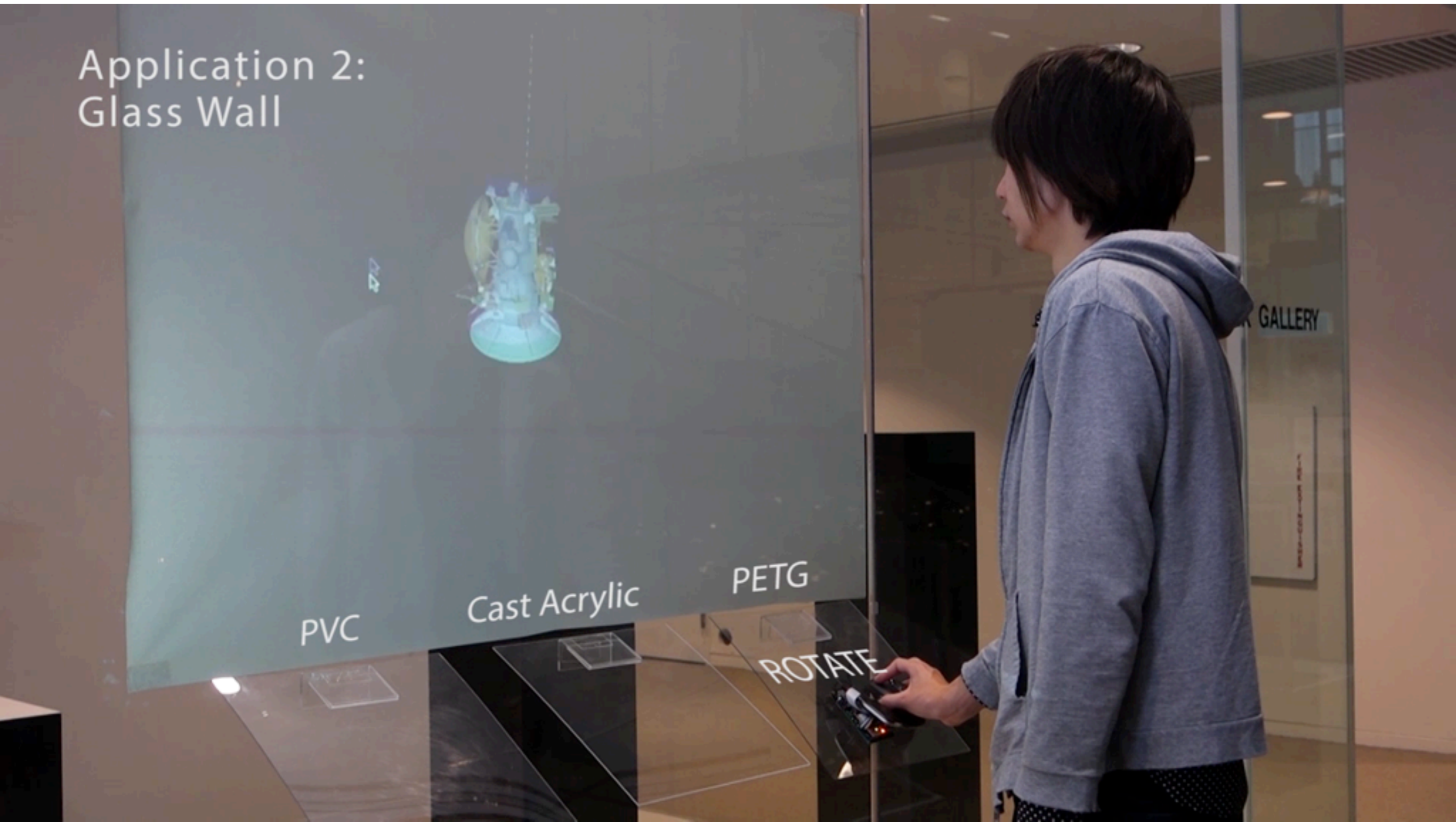
PVC

Cast Acrylic

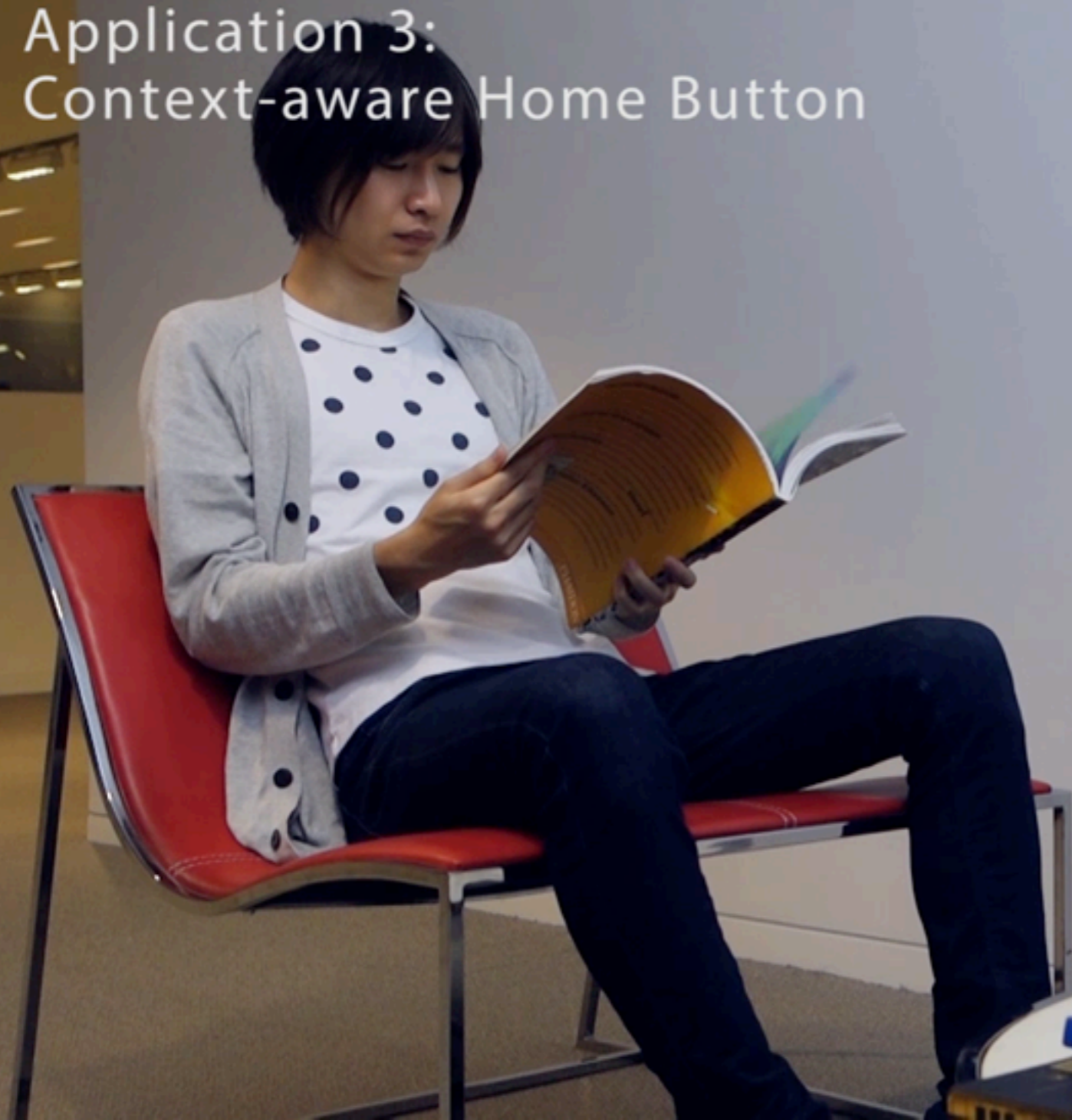
PETG

ROTATE

GALLERY

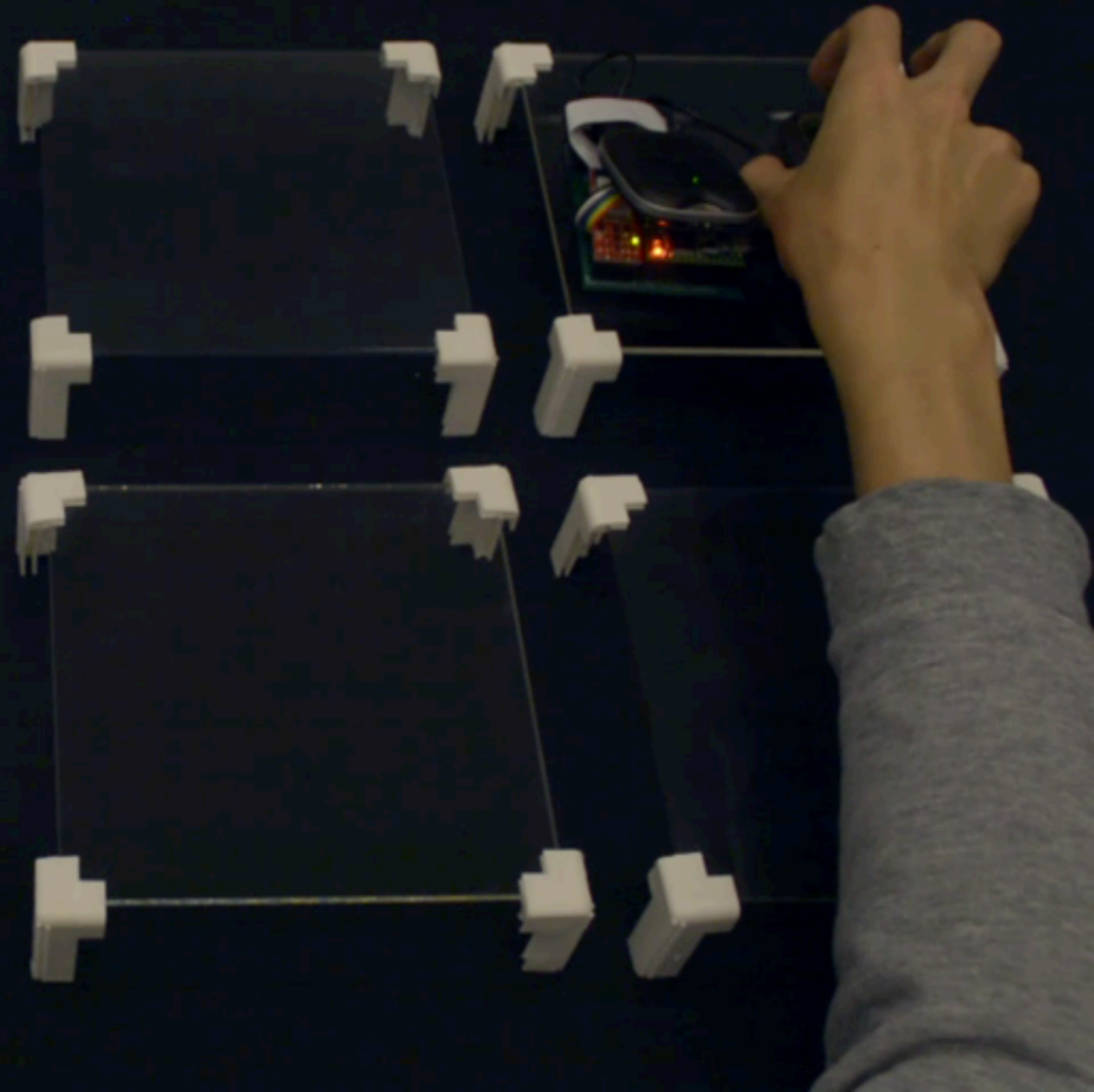


Application 3: Context-aware Home Button





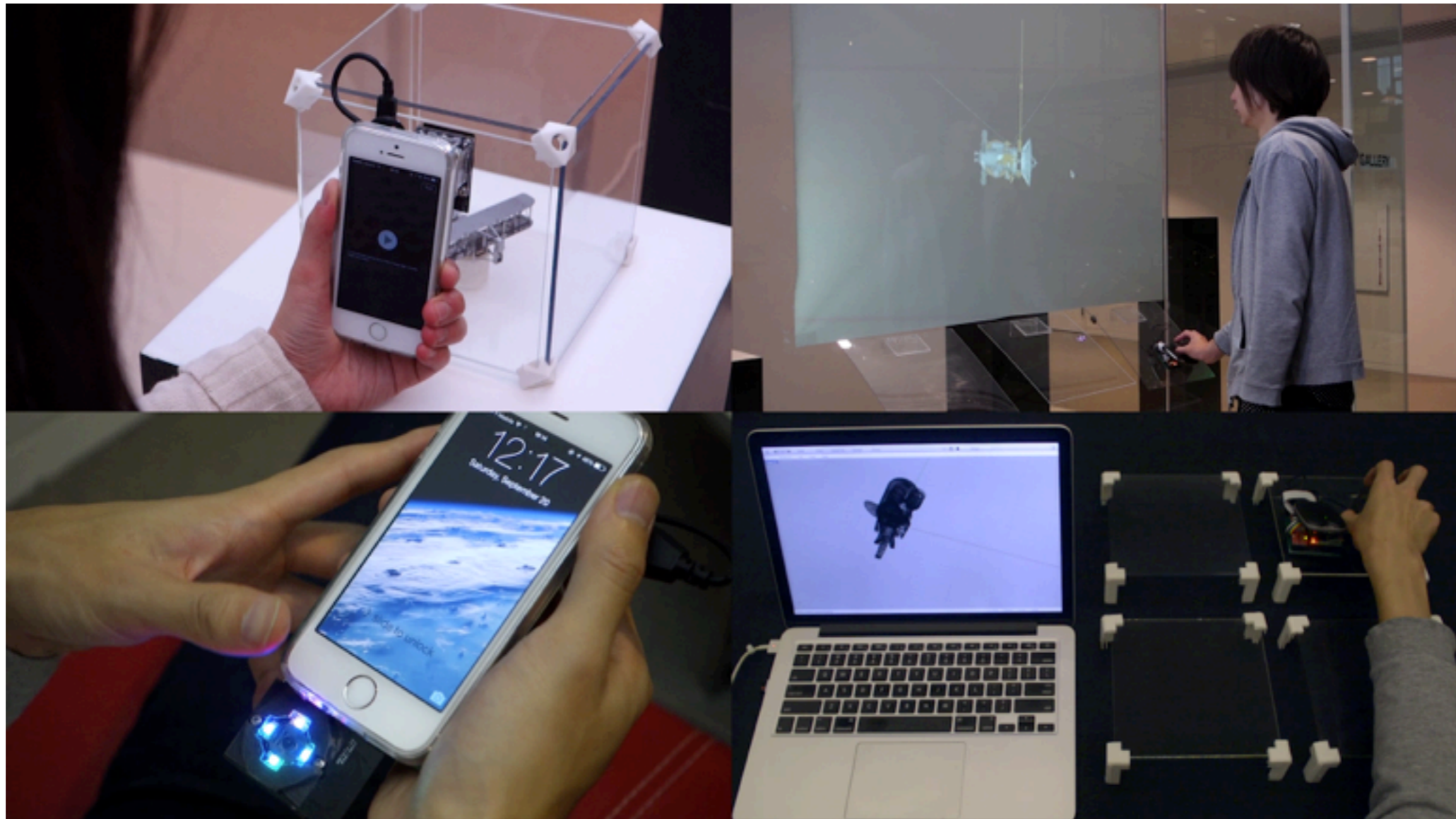
Application 4:
Switching Viewports in 3D CAD



Application 5:
Graspable Transparent Layers



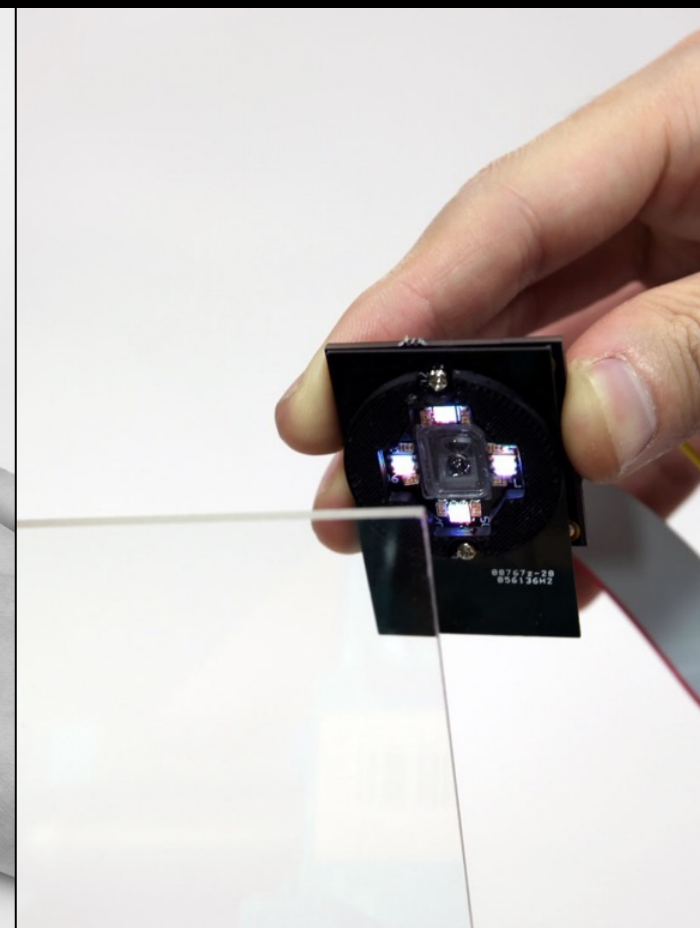
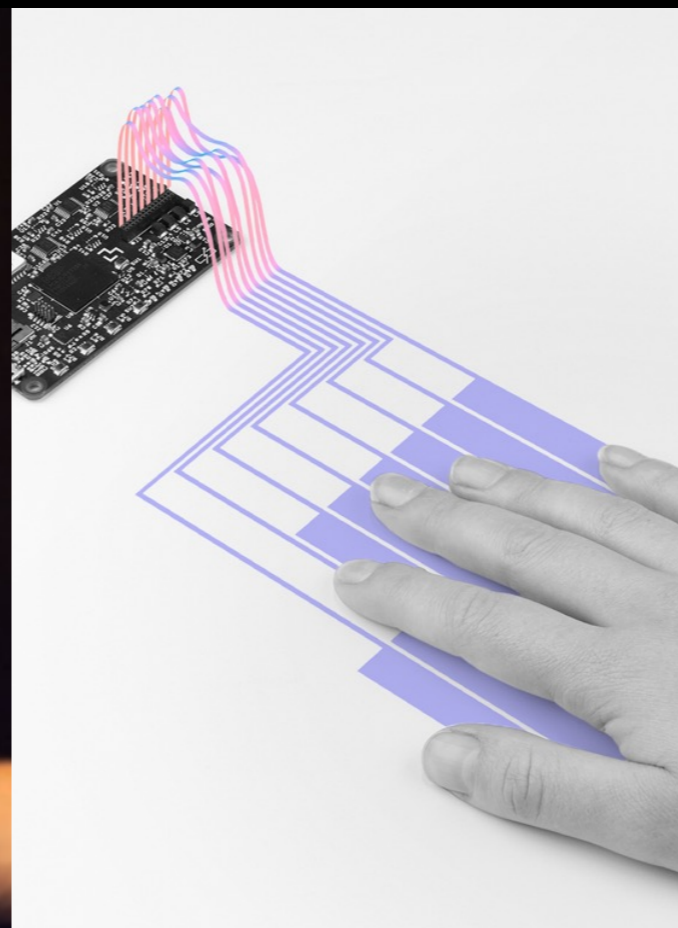
Applications of SpecTrans



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Links

- Personal Website

- <http://www.satomunehiko.com>
- [list of all projects \(with videos and papers\)](#)
- [list of all papers](#)

- YouTube channel

- https://www.youtube.com/playlist?list=PLP5huhWF50Cg0H73sBBk_gzObrWGx6-eS

- Google Scholar

- <https://scholar.google.com/citations?user=ypdwOoMAAAAJ>

- LinkedIn

- <https://www.linkedin.com/in/munehikosato>