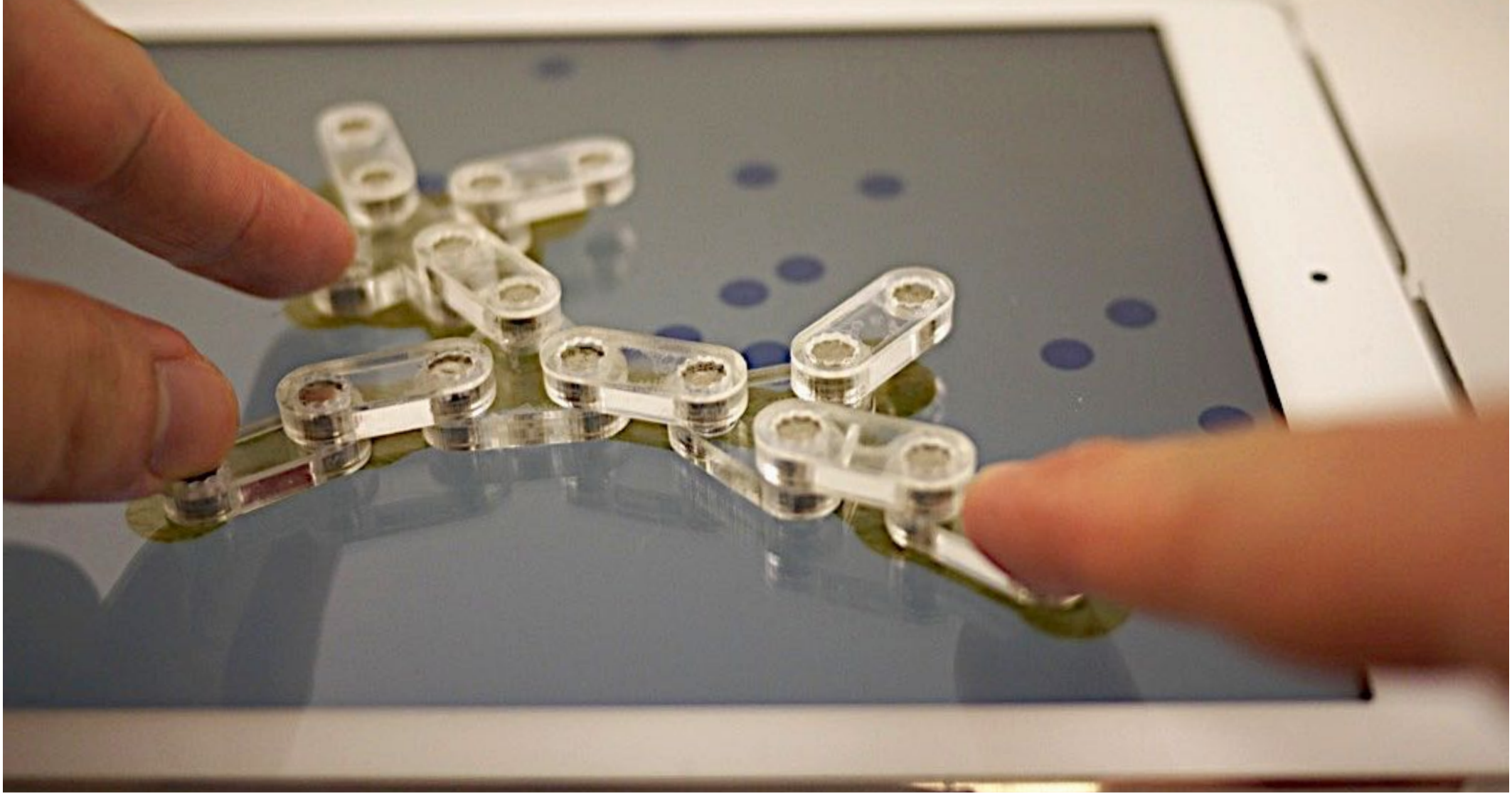
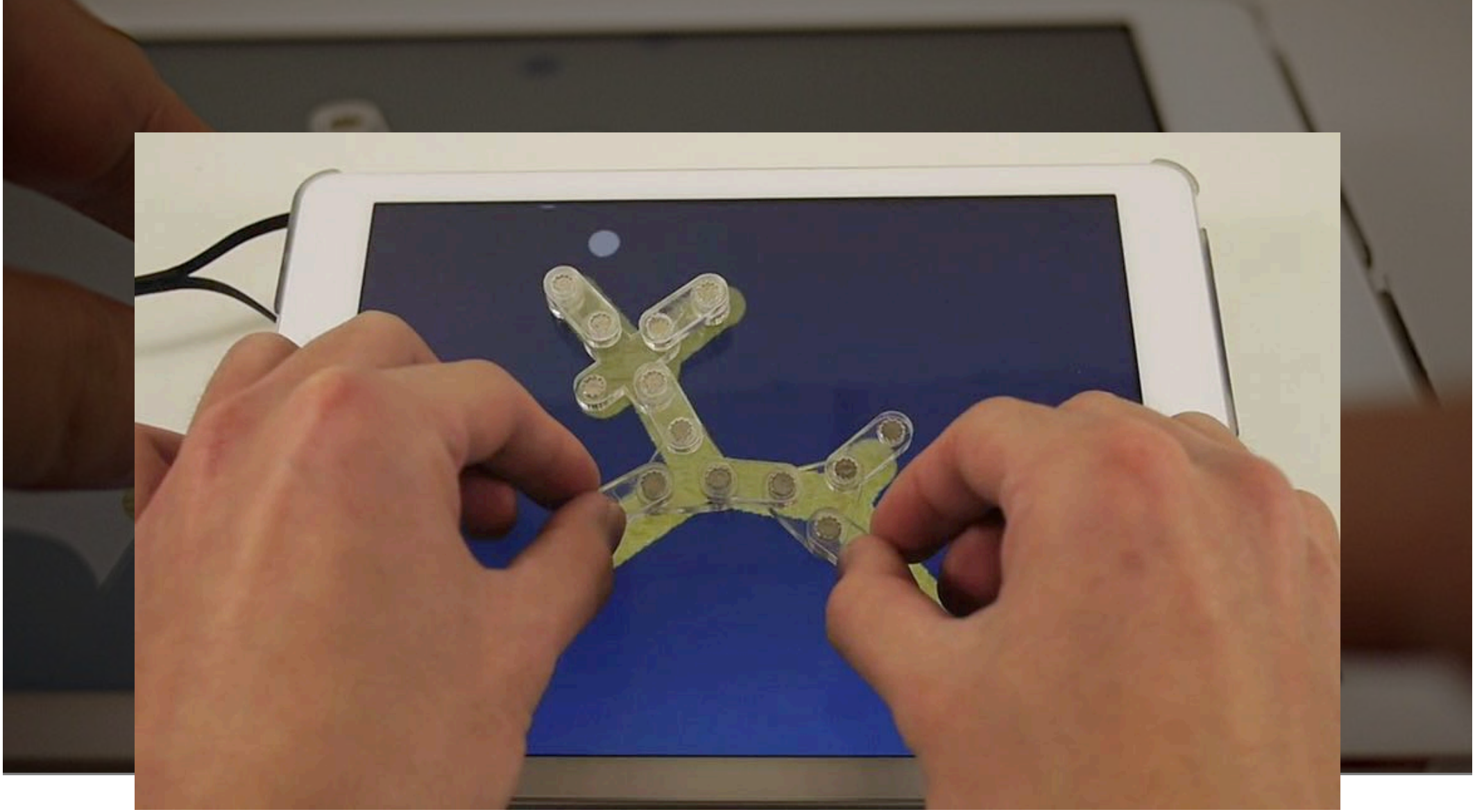


GaussBricks:

Magnetic Building Blocks for **Constructive Tangible Interactions** on **Portable Displays**

Rong-Hao Liang, Liwei Chan, Hung-Yu Tseng, Han-Chih Kuo, Da-Yuan Huang,
De-Nian Yang, and Bing-Yu Chen
National Taiwan University & Academia Sinica

CHI 2014
One of a CHInd



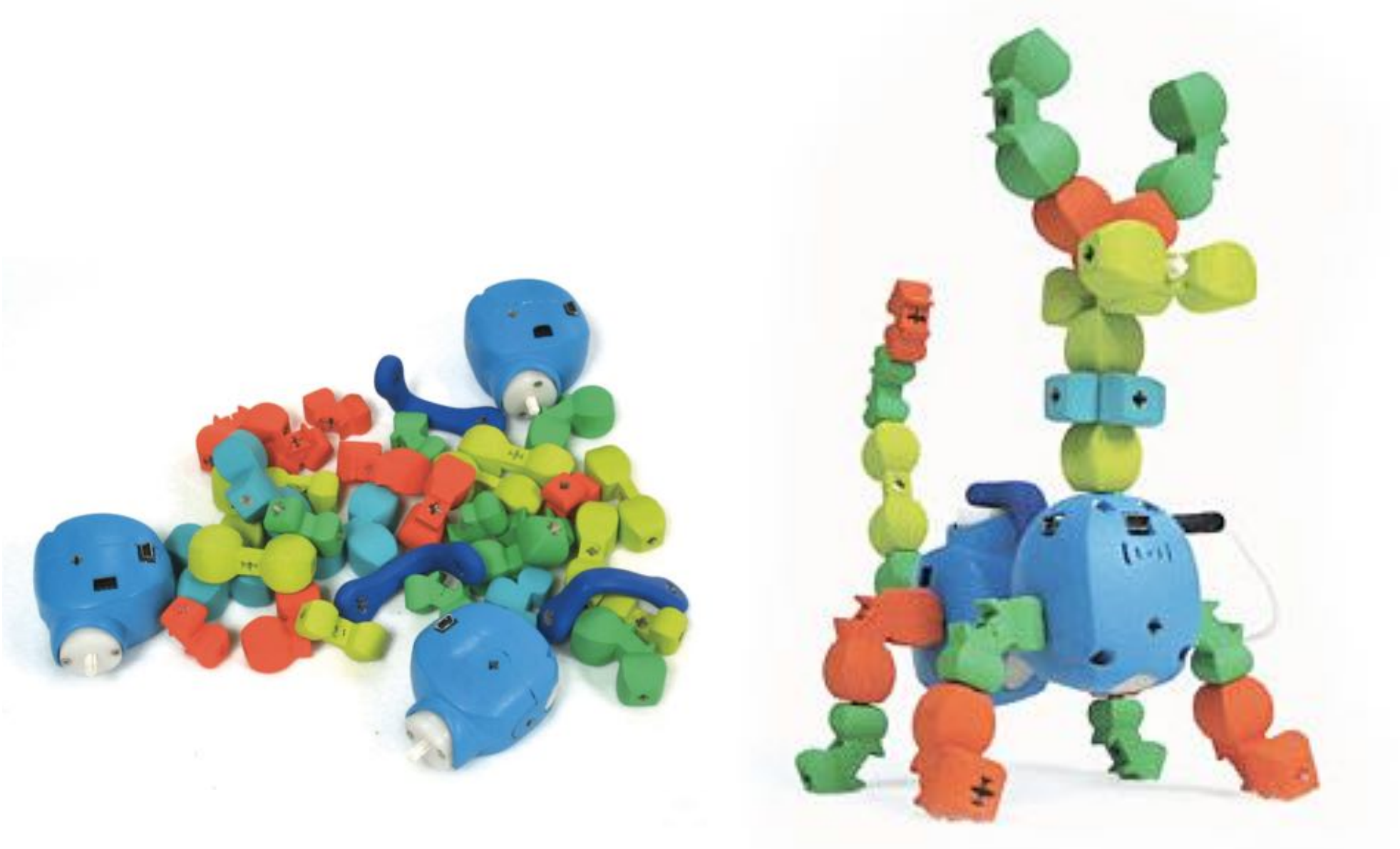
Creating Physical Forms to Interact with Virtual Contents on Portable Displays

Building Blocks

Creating Geometries and Structures

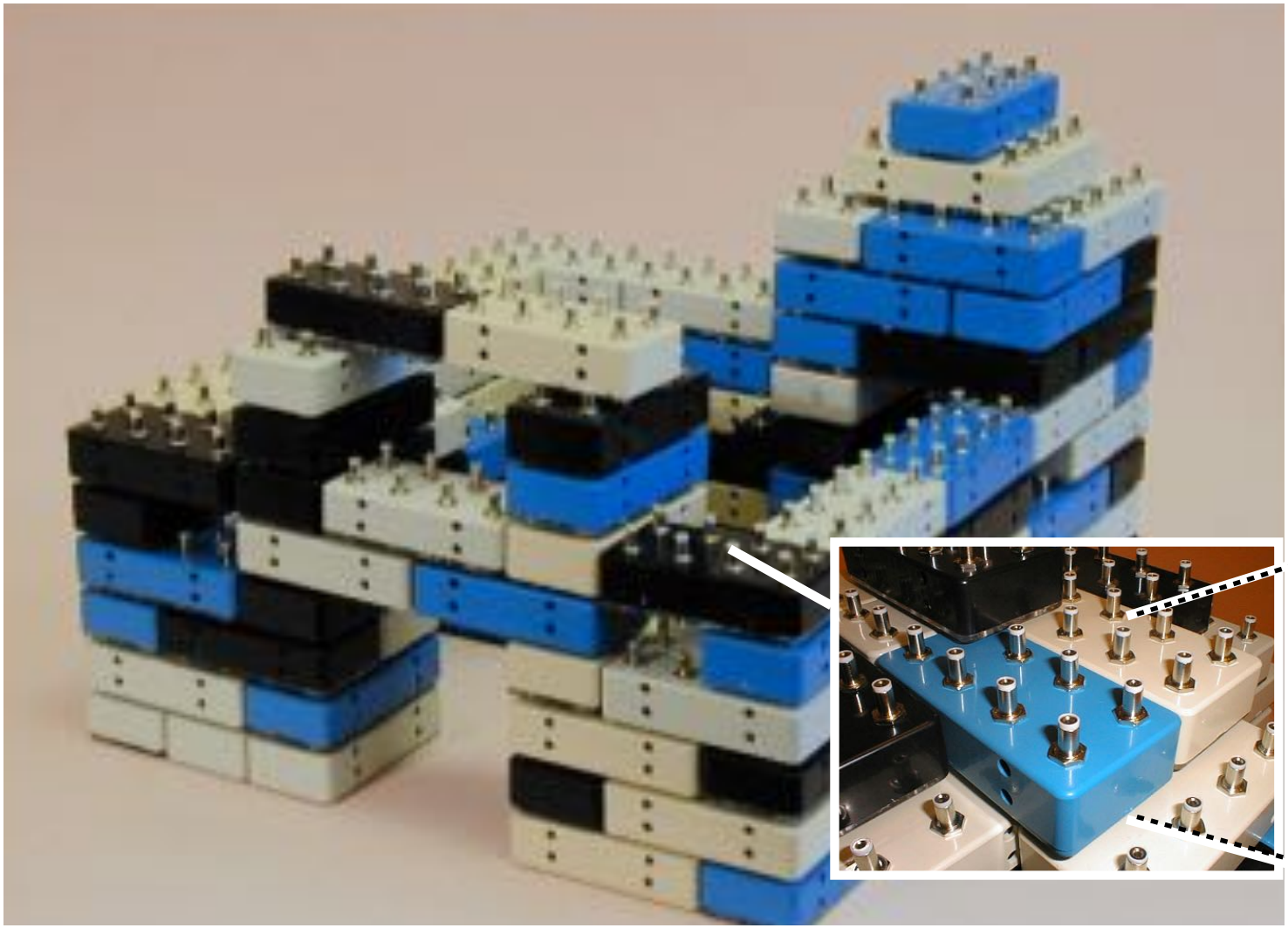
by Nathan Sawaya

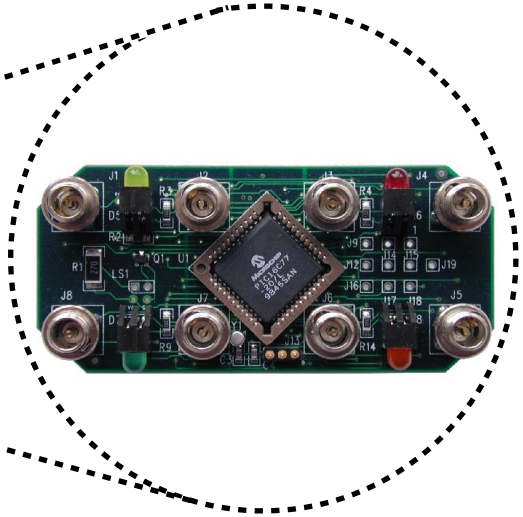
Creating Mechanical Movements



Constructive Assembly TUIs

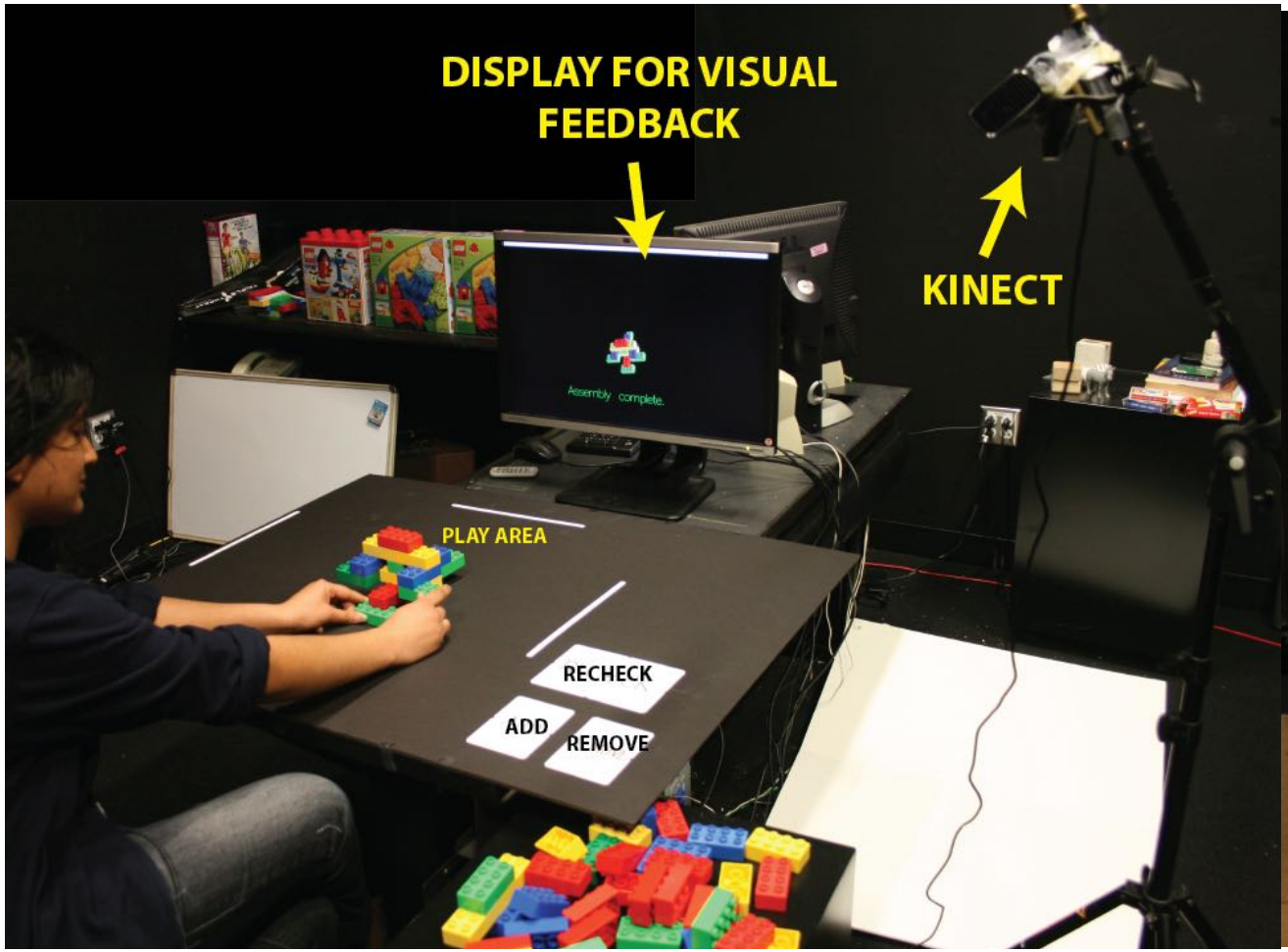
Topobo [Raffle et. al. CHI '04]

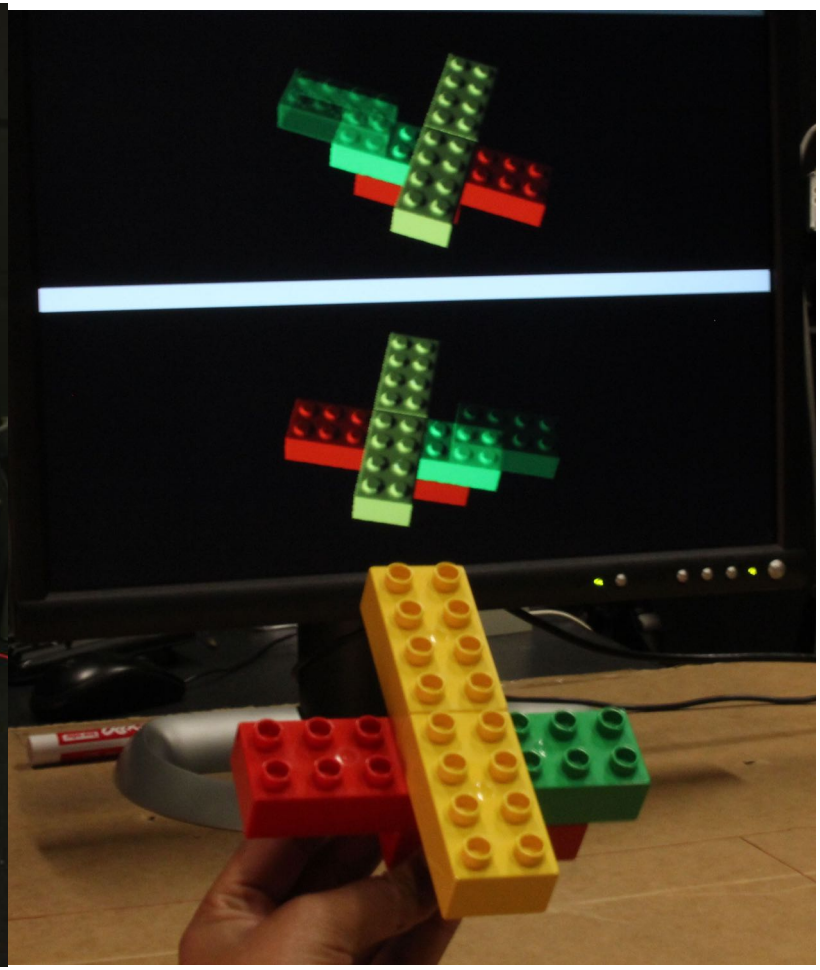




Blocks [Anderson et. al. SIGGRAPH '00]

Active Blocks: battery & microcontroller

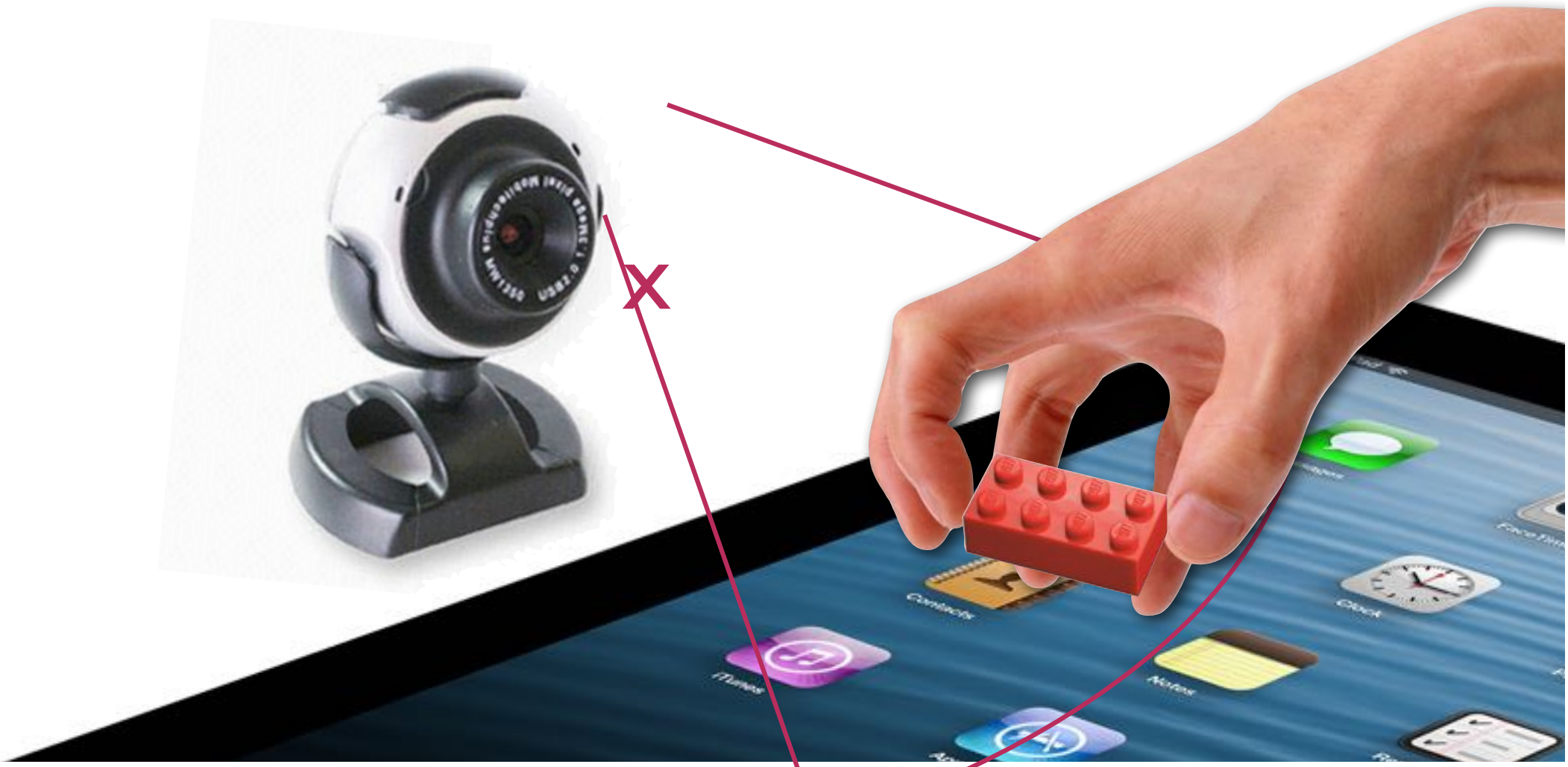




DuploTrack [Gupta et. al. UIST '12]

Passive blocks - Cameras

Portable Displays



Passive blocks - Optical Camera

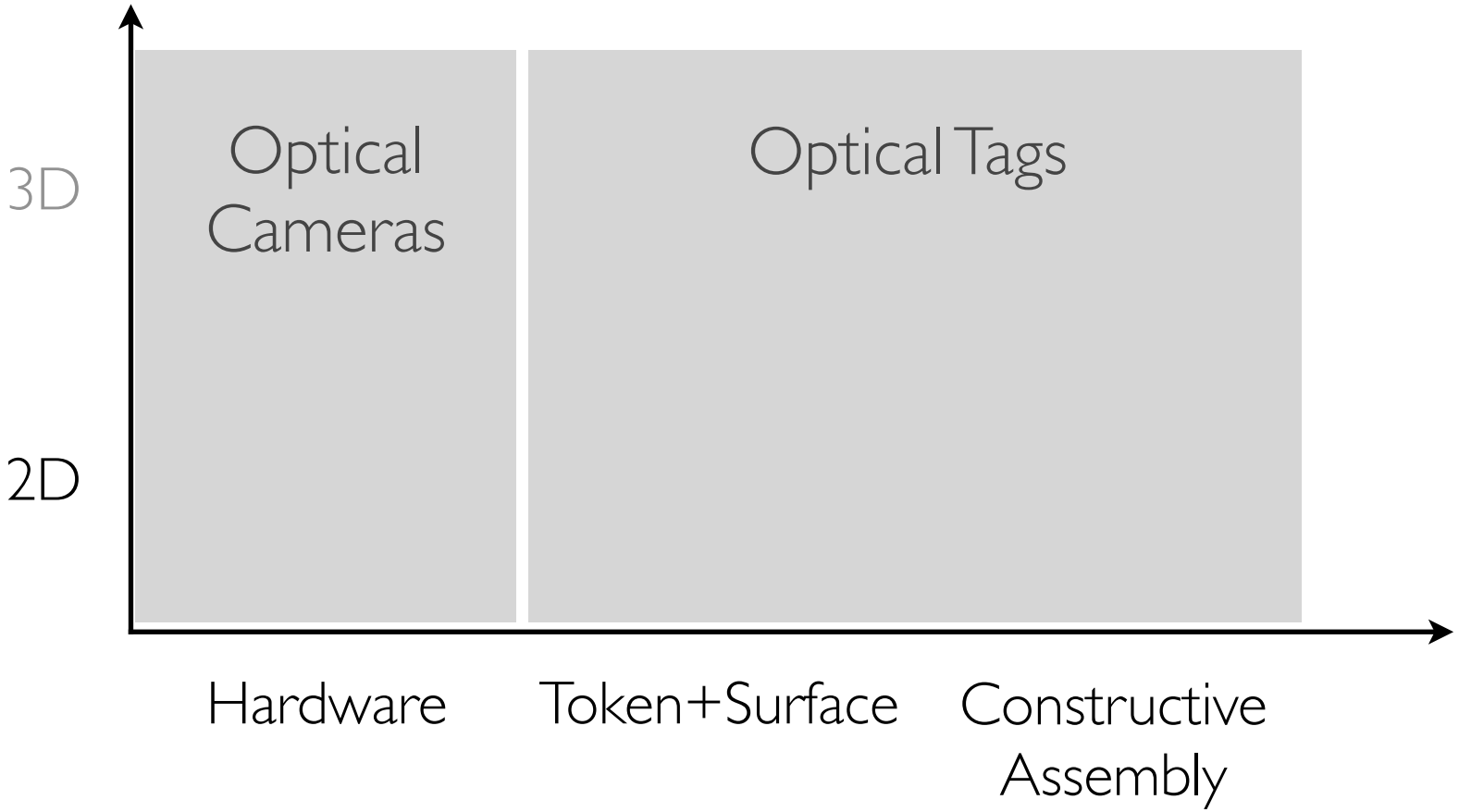
Passive blocks - Capacitive Tracking

Capstones

[Chan et. al. CHI '12]

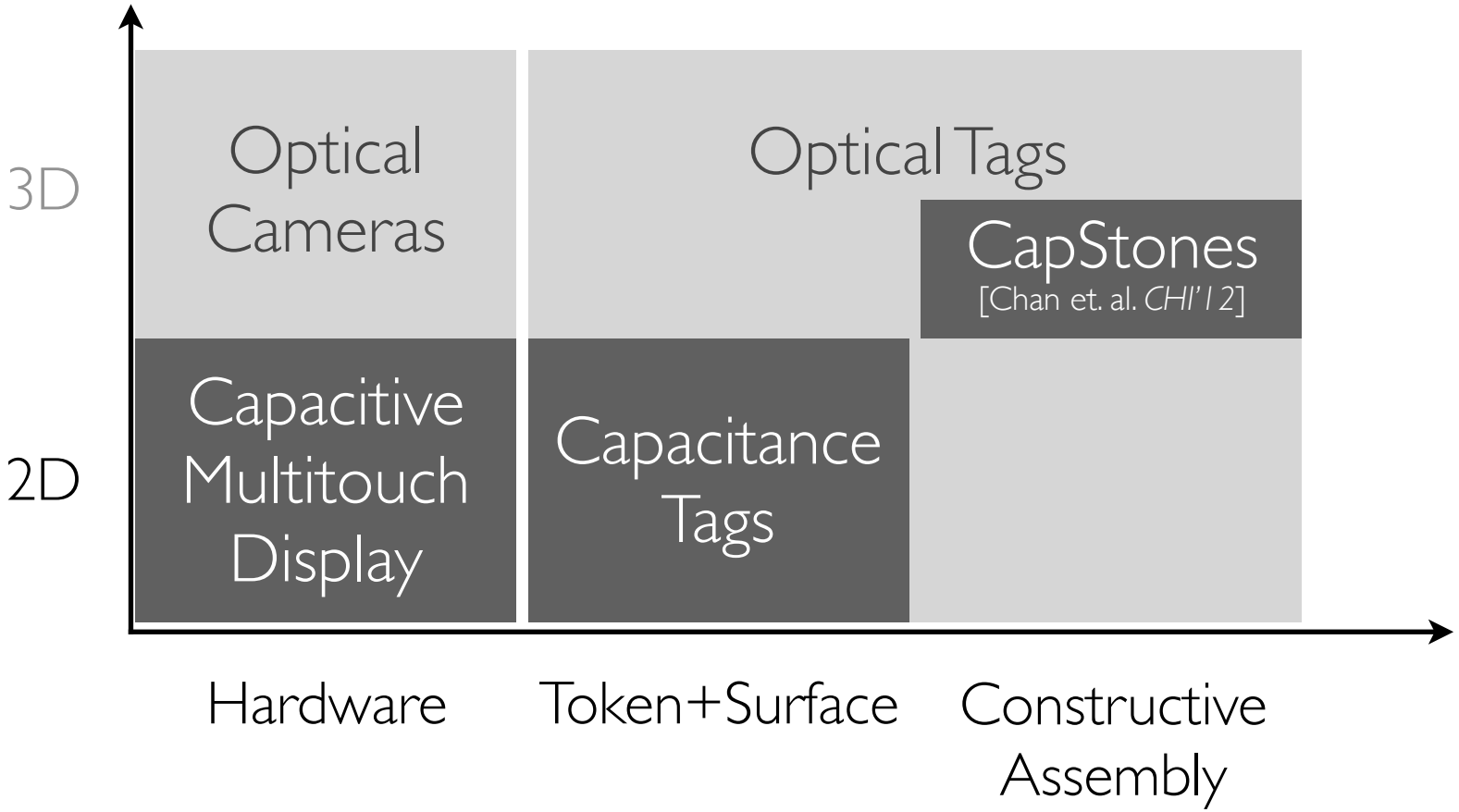
Passive blocks - Capacitive Multitouch Displays

Optical tracking is occlusion-sensitive



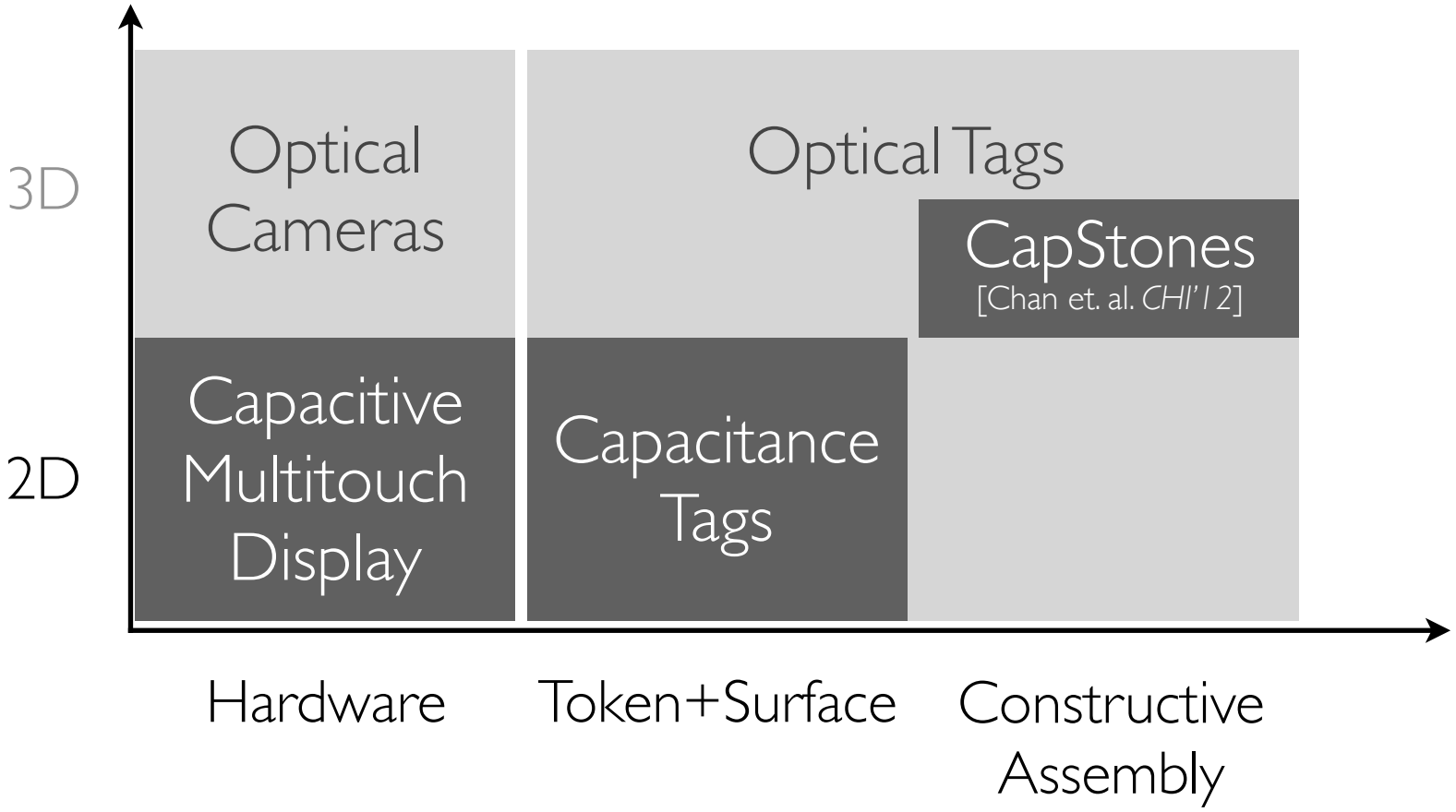
TUI Design Space** of **Portable Displays

Capacitive tracking cannot effectively support form construction



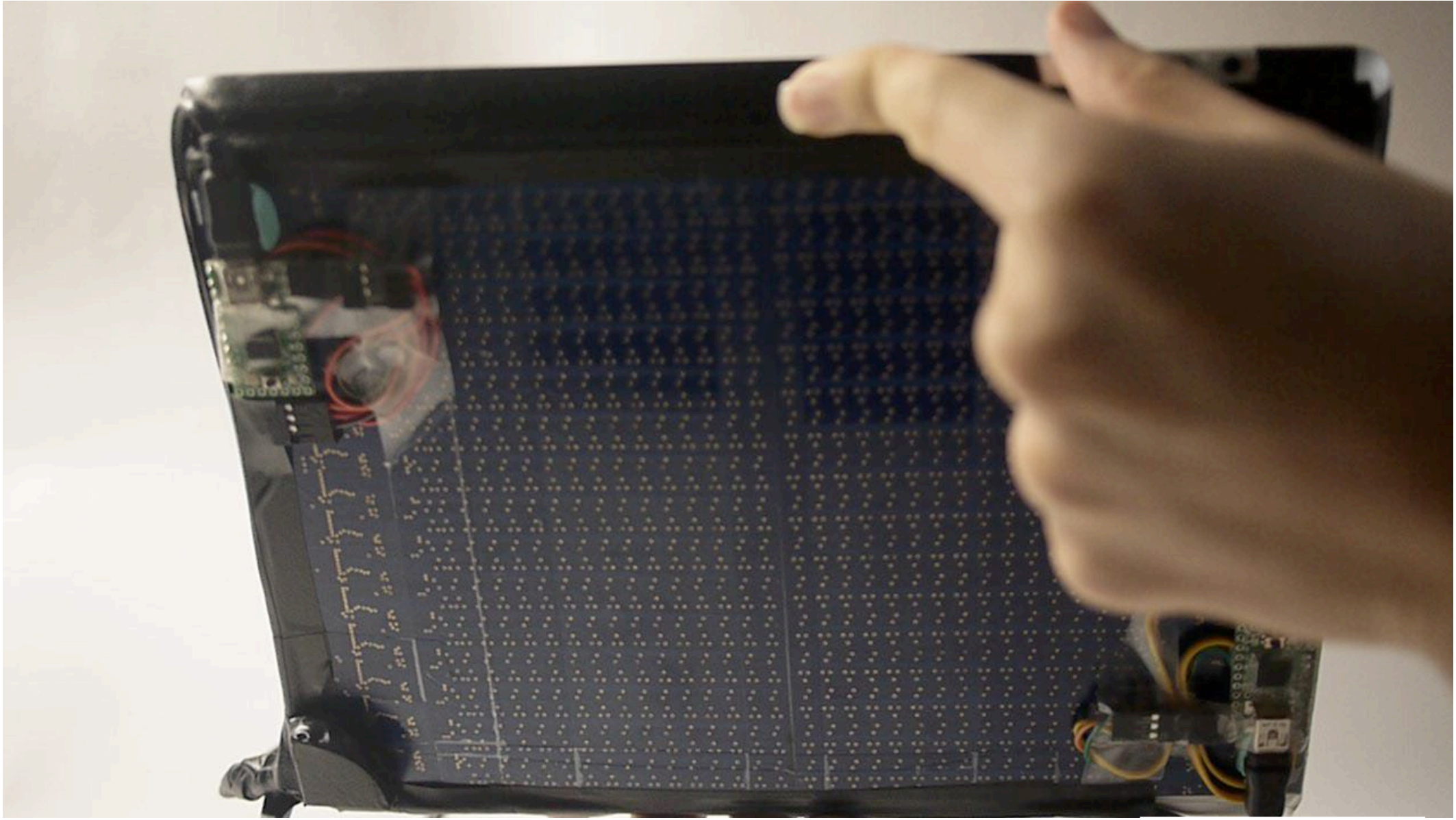
TUI Design Space** of **Portable Displays

New Materials and Techniques are Needed



TUI Design Space** of **Portable Displays

Magnetic Tangibles



Analog Hall-Sensor Grid

portable magnetic-field camera

GaussSense

Attachable
Hall-Sensor Grid
[Liang et al. *UIST'12*]

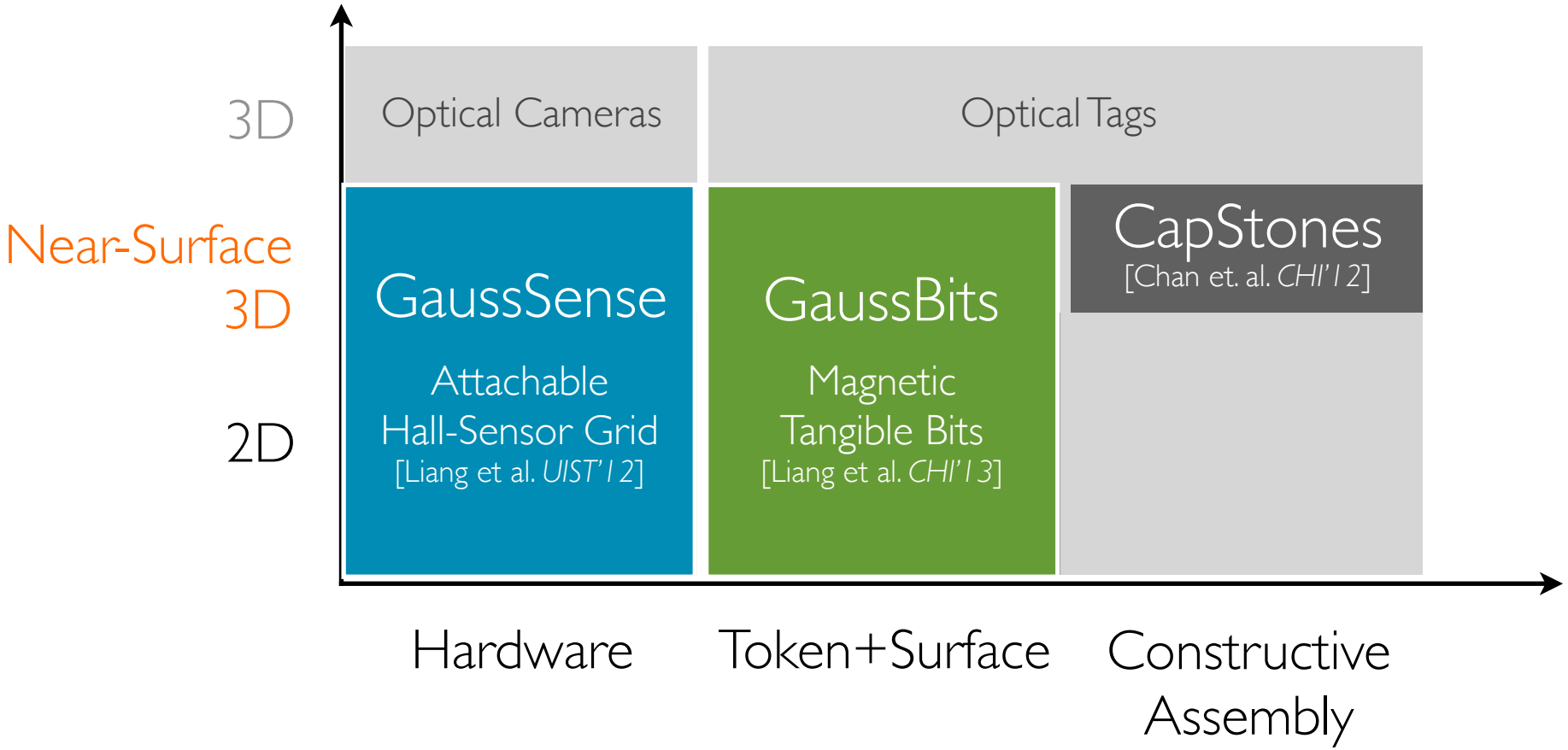
Magnetic Tangibles

passive, small, and occlusion-free

GaussBits

Magnetic Tangible Bits [Liang et al. *CHI'13*]

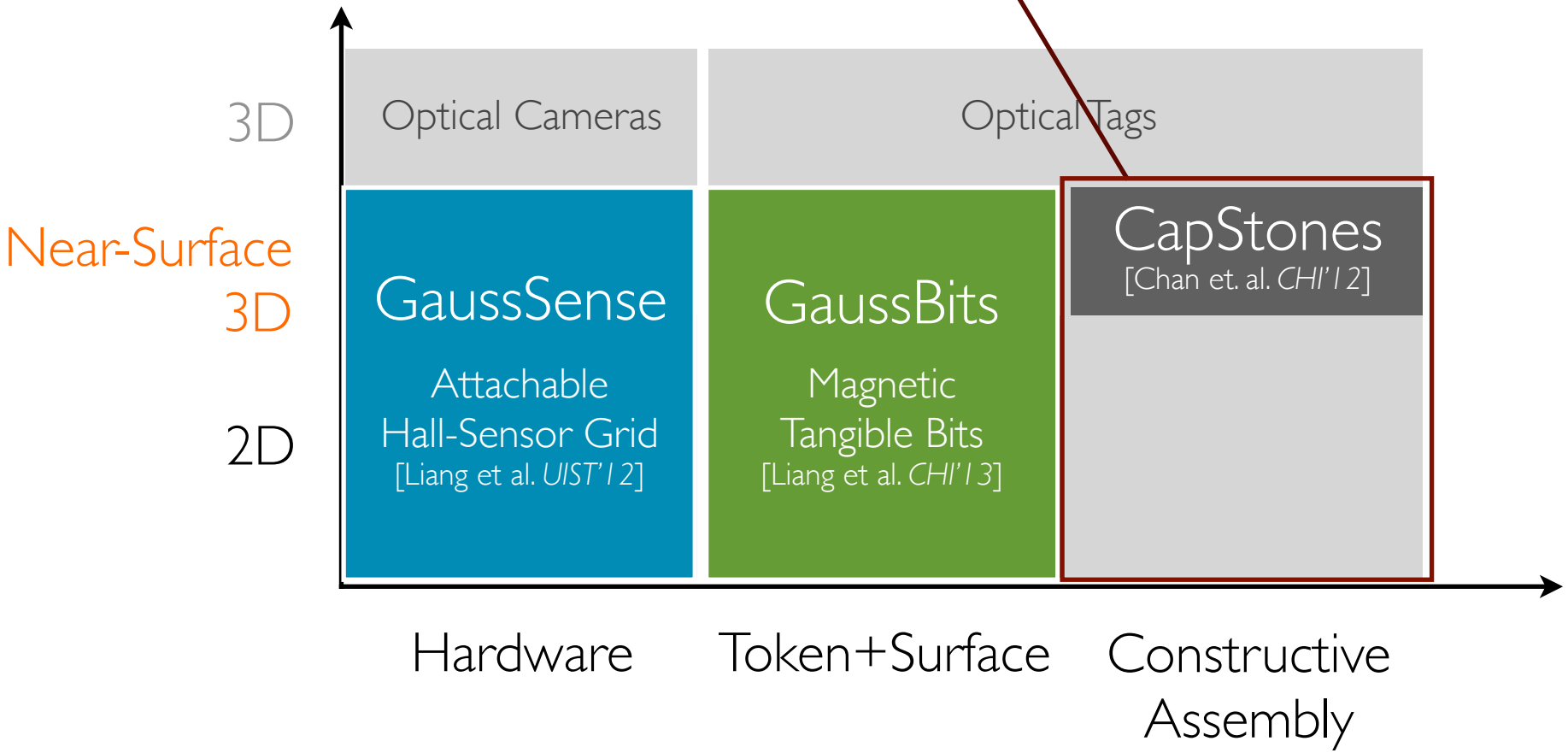
A **technique** and **material** that support
Portable and Occlusion-Free Interaction Design
On and Above Portable Displays



TUI Design Space** of **Portable Displays

A **technique** and **material** that

Feasible for Designing Building Blocks by Magnets?



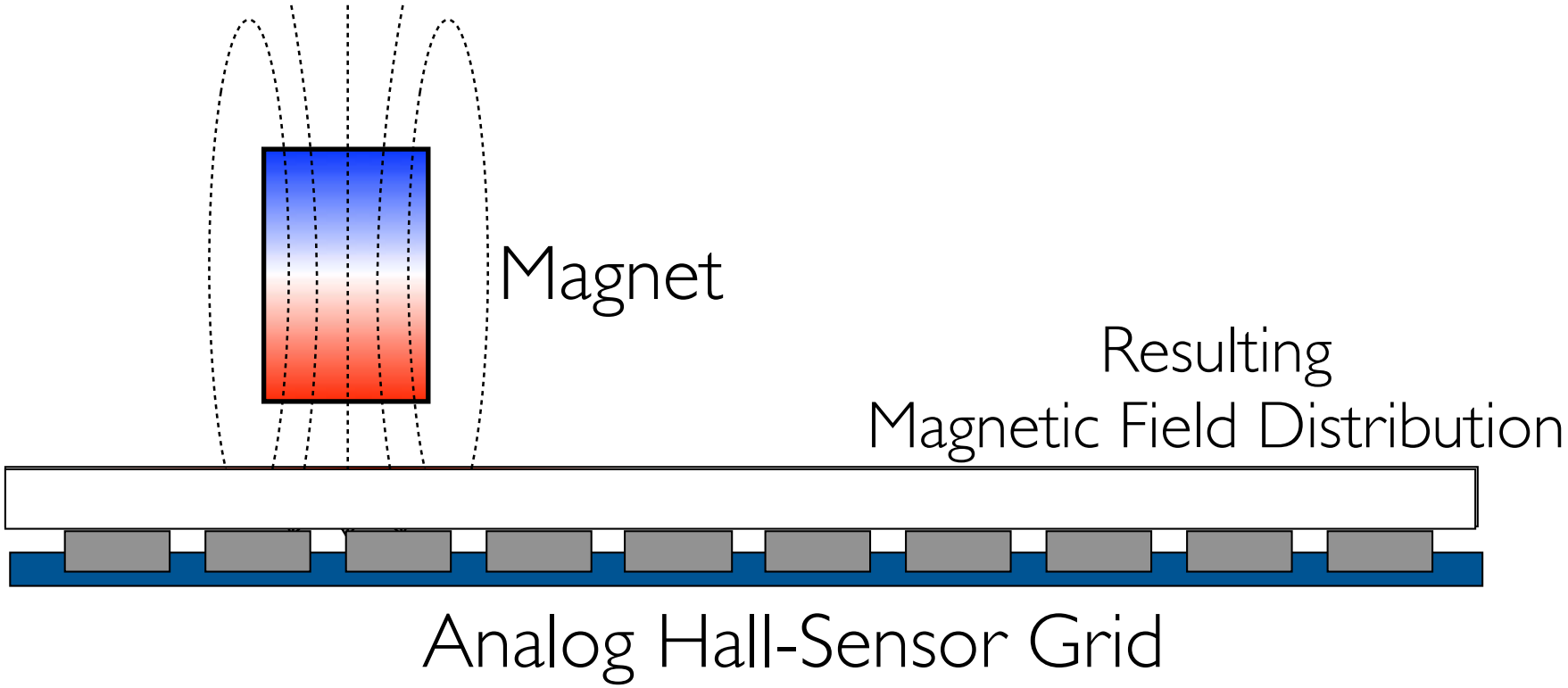
TUI Design Space** of **Portable Displays

Magnets

Magnets naturally **attract** together

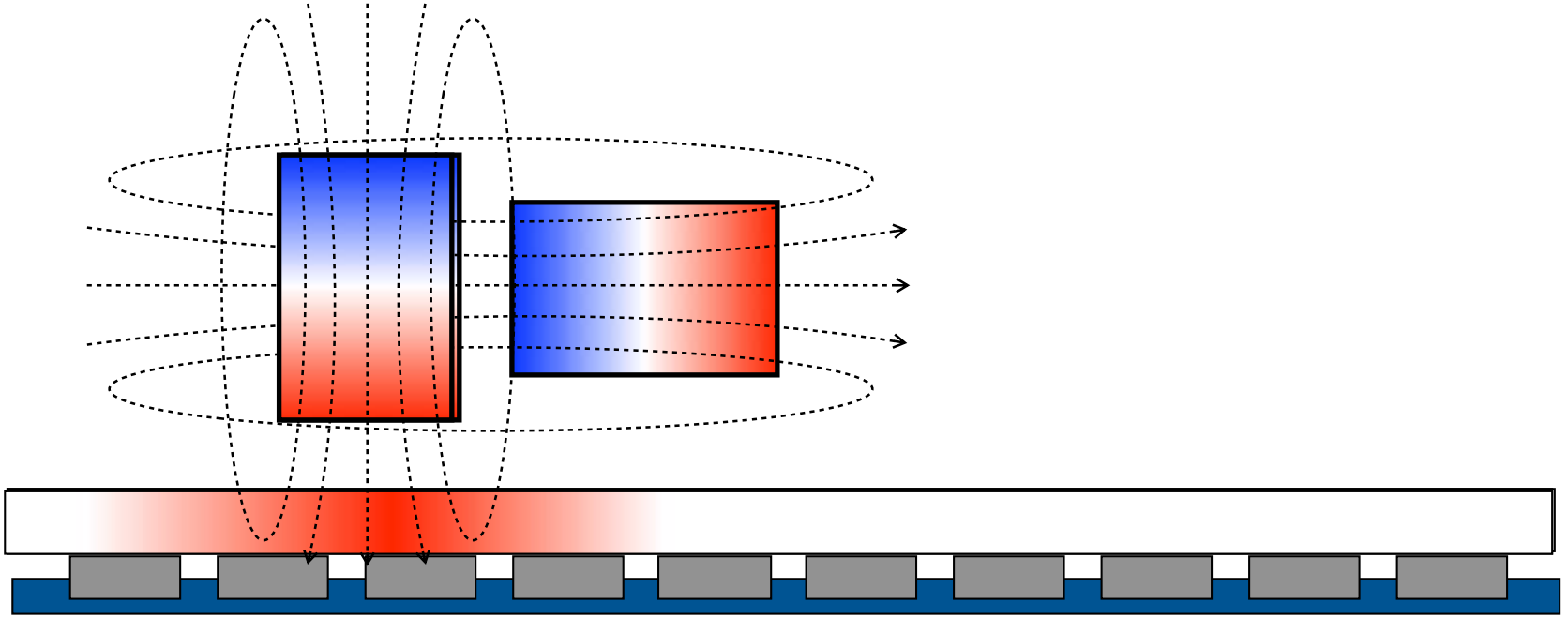
Challenge on Sensing

The distribution of magnetic field may differ from the shape of magnetic sculpture



Challenge on Sensing

The distribution of magnetic field may differ from the shape of magnetic sculpture

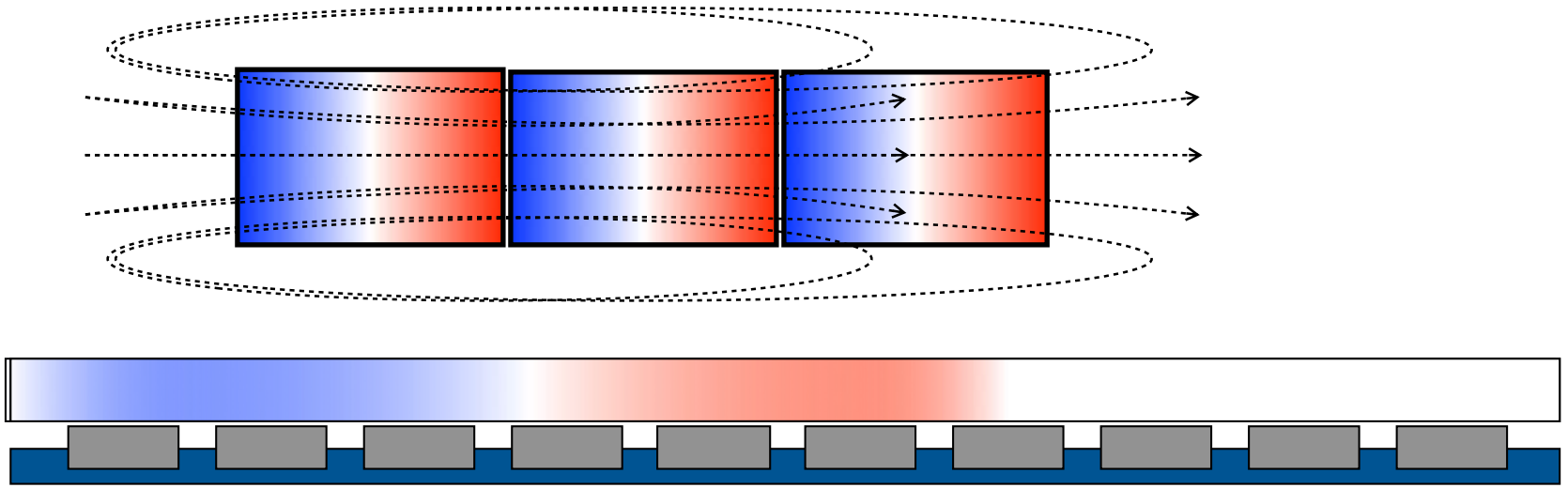


Analog Hall-Sensor Grid

Magnet attracting each other also counteract each other

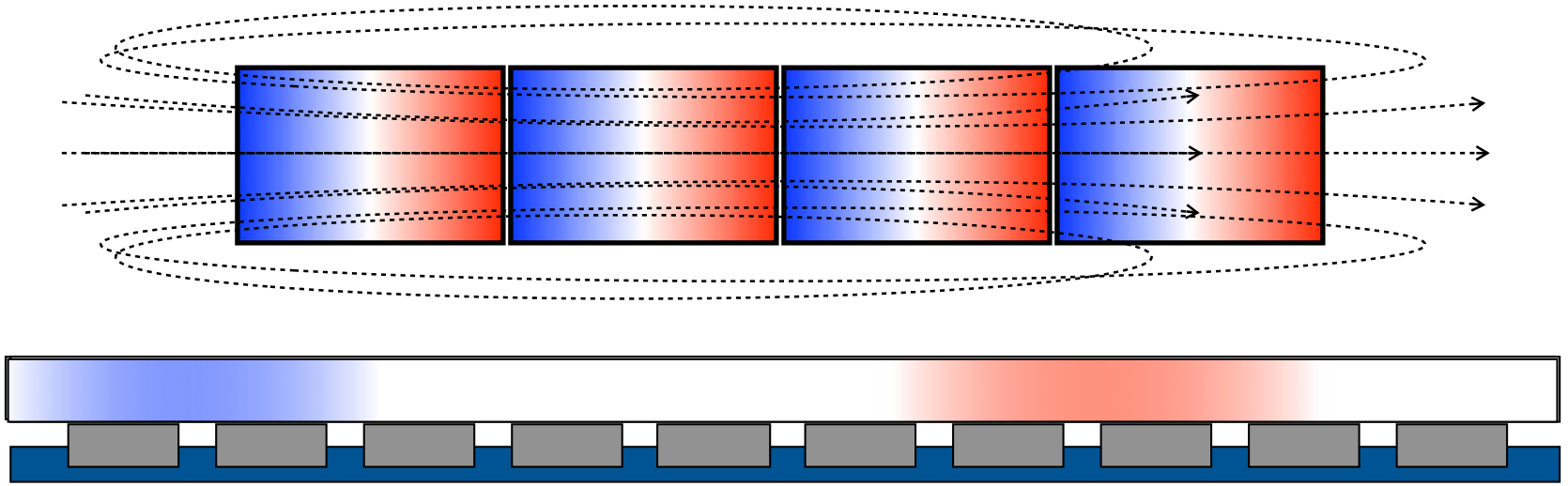
Challenge on Sensing

The distribution of magnetic field may differ from the shape of magnetic sculpture



Analog Hall-Sensor Grid

Magnet attracting each other also counteract each other



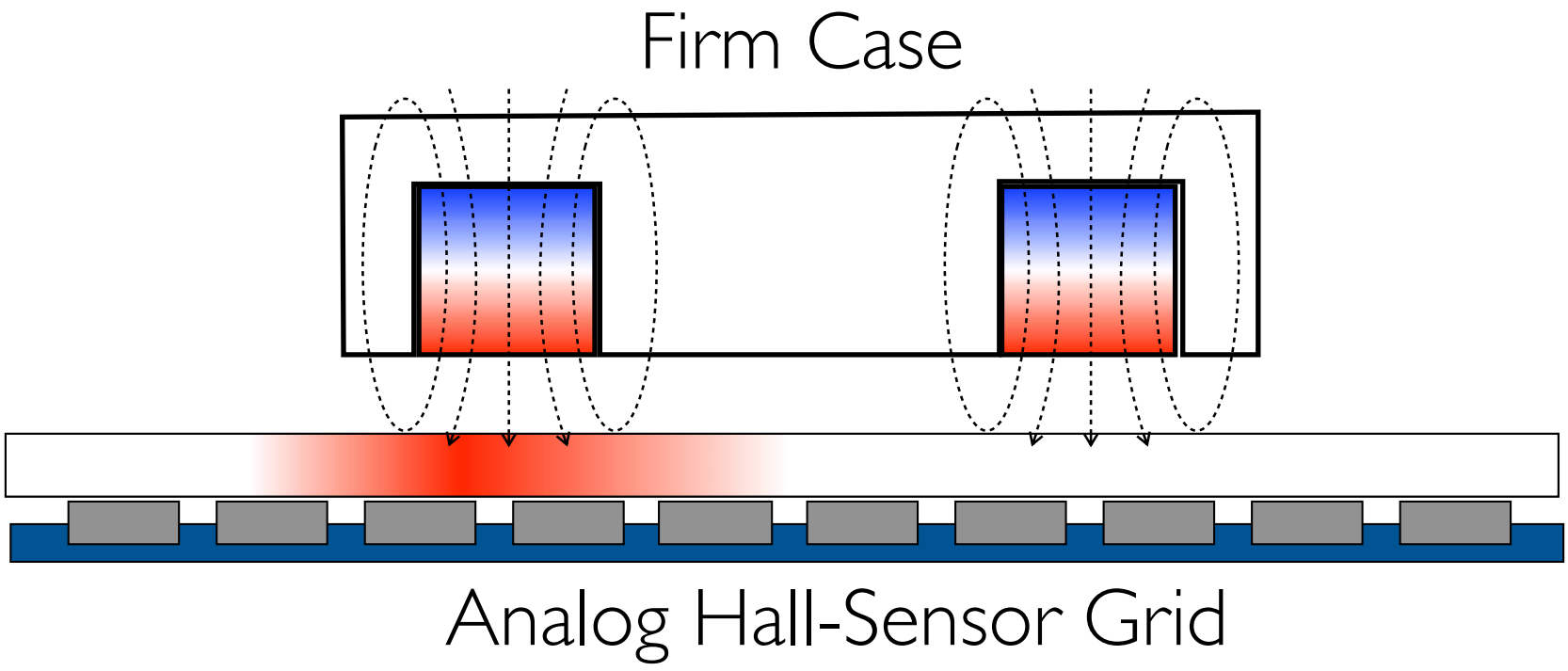
Analog Hall-Sensor Grid

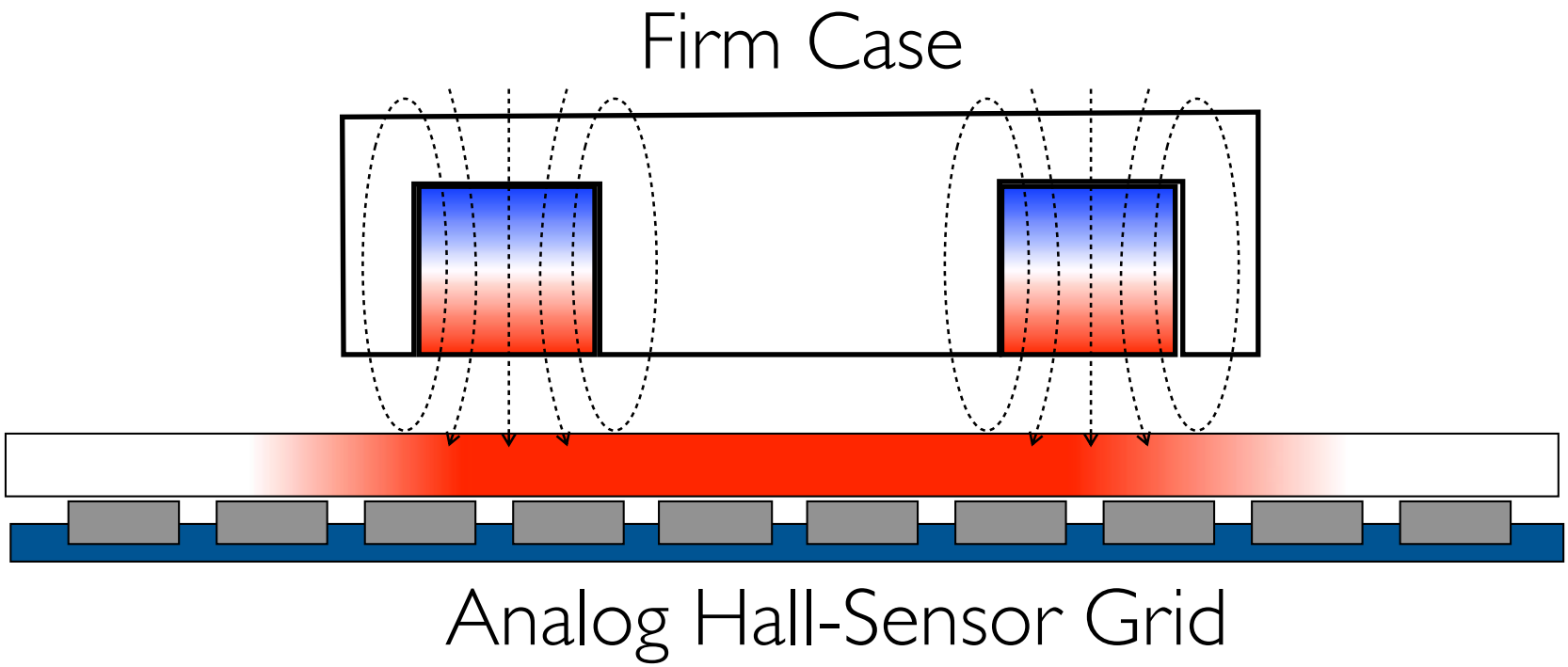
Magnet attracting each other also counteract each other

Shaping the Magnetic Fields for Sensing

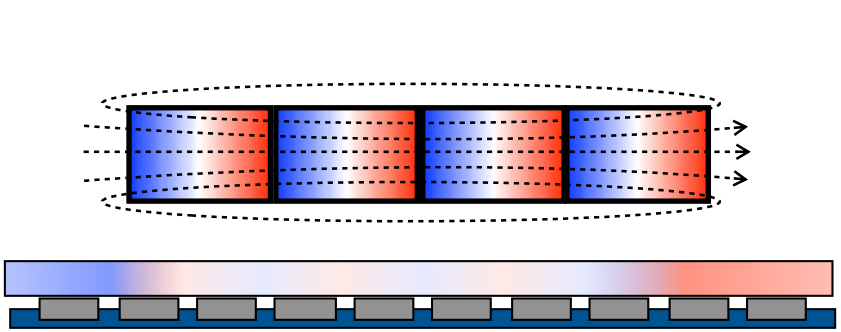
Keep the construction's magnetic field

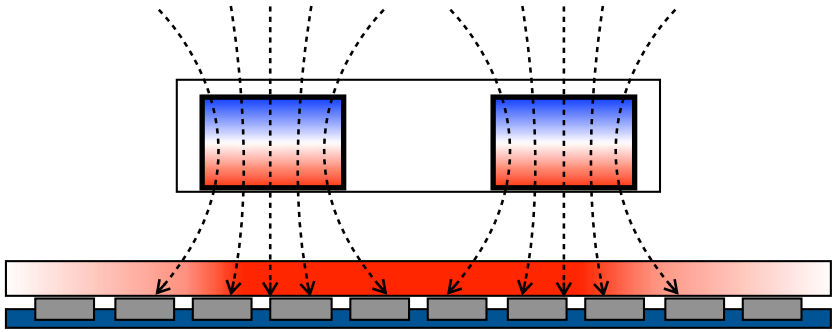
in the same polarity

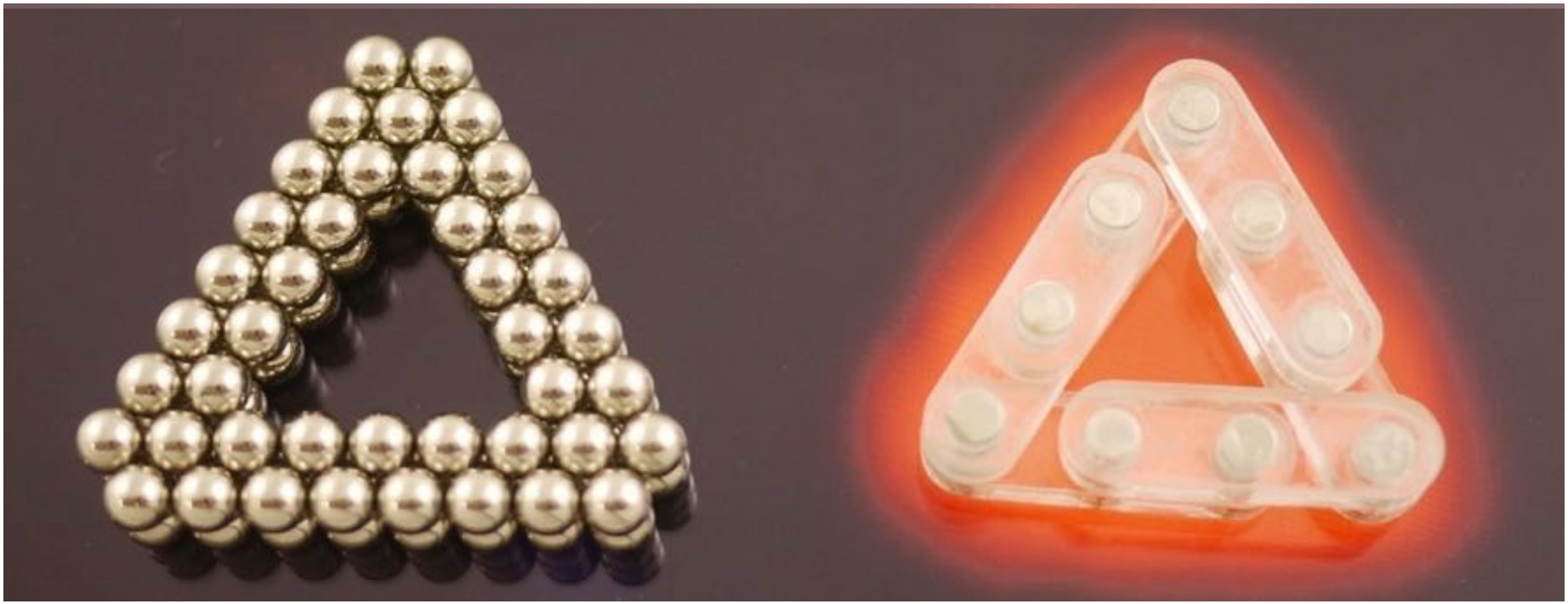


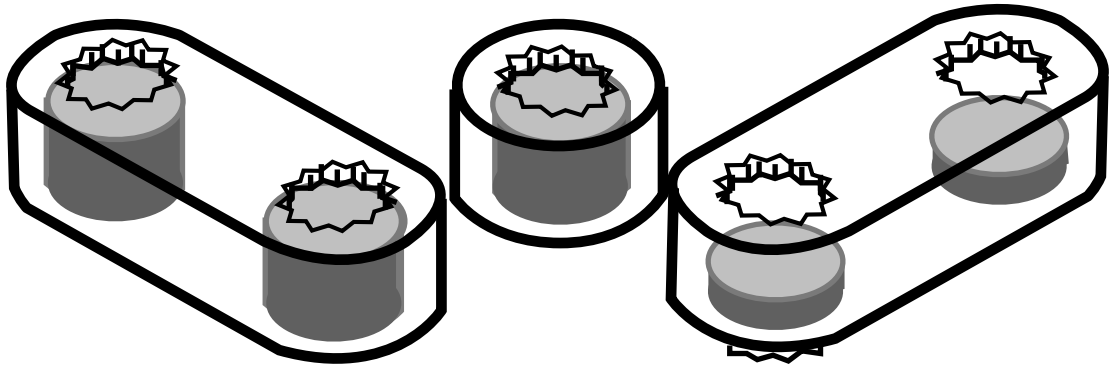

Firm Case
Analog Hall-Sensor Grid

Valid magnetic-field distribution for deriving the geometry of a magnetic construction

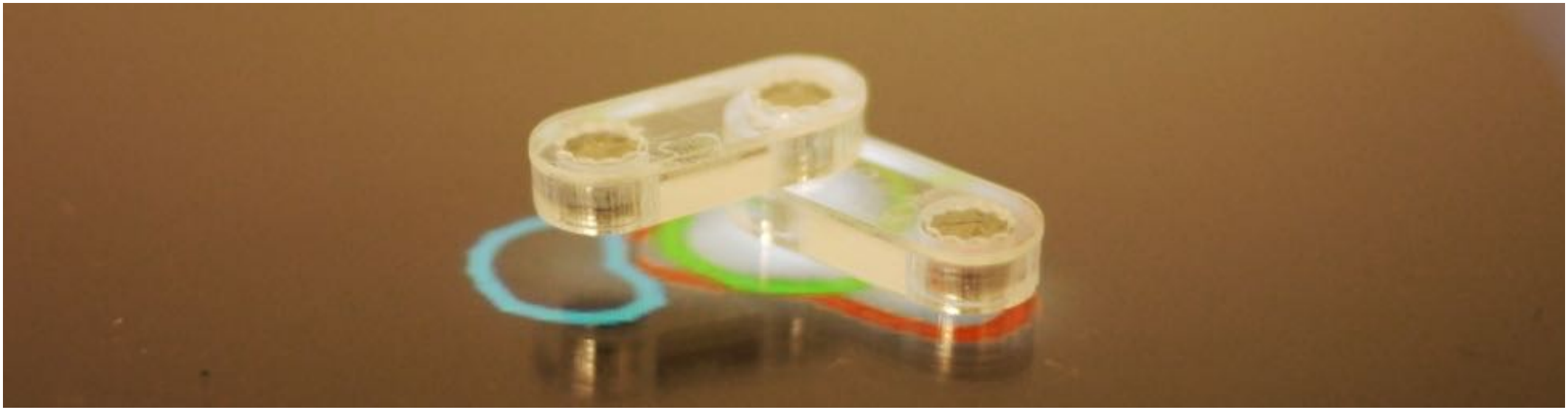




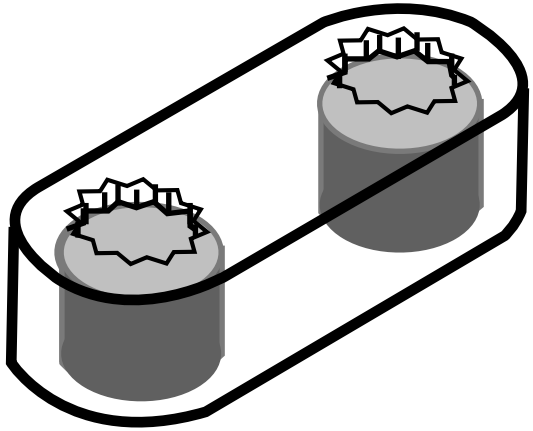


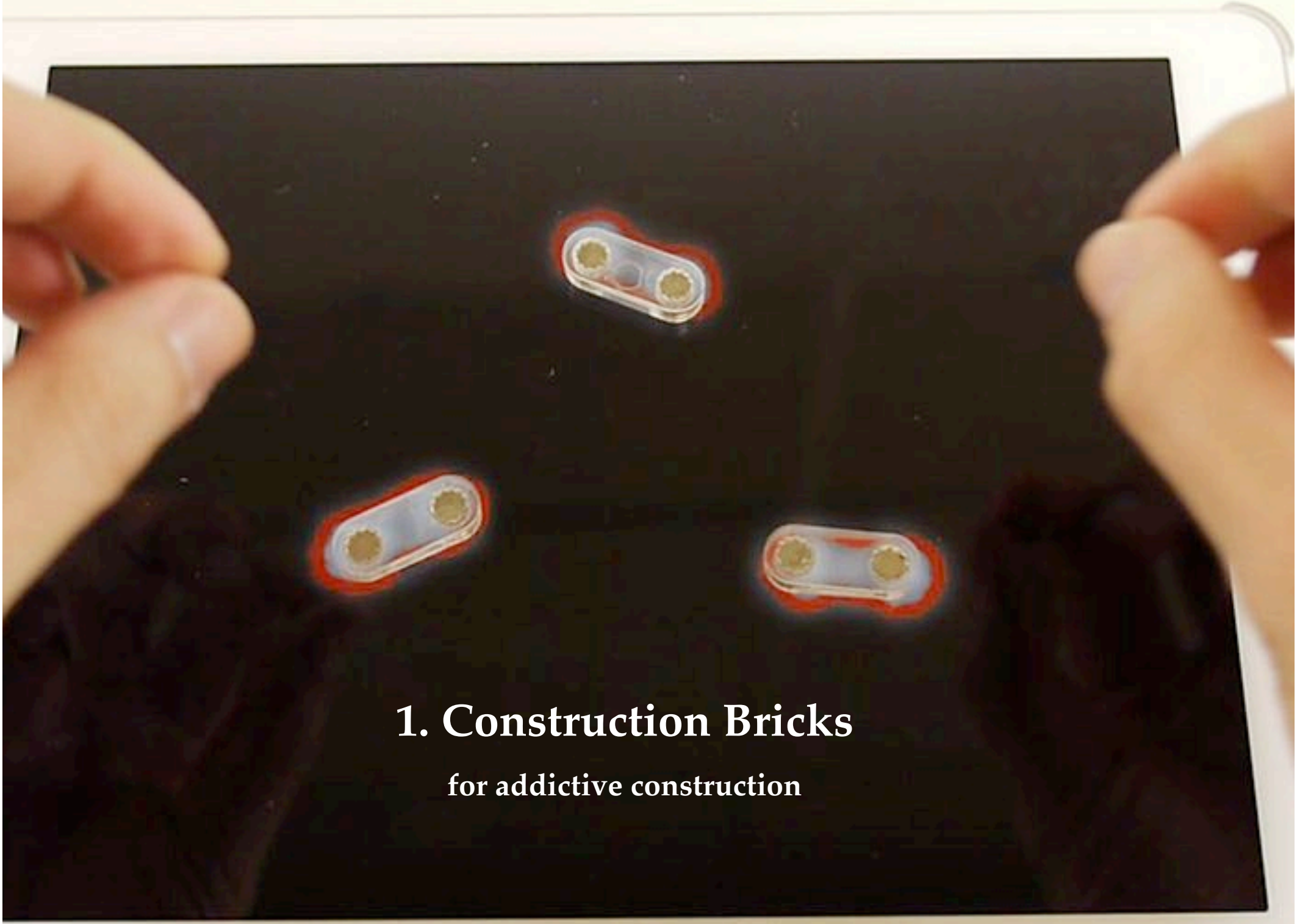


3 Types of GaussBricks



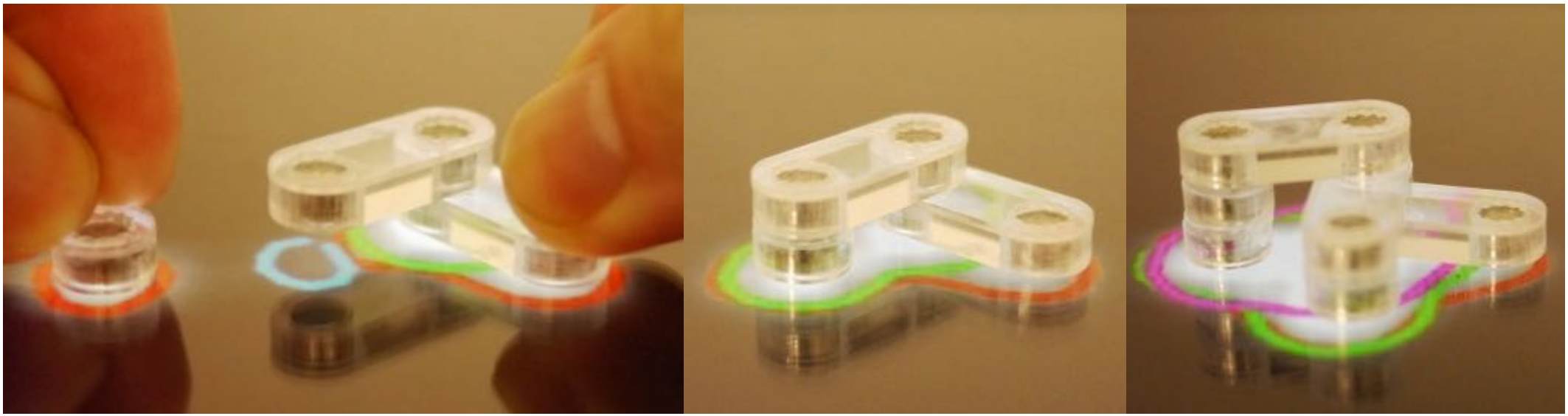
1. Construction Bricks: for additive construction





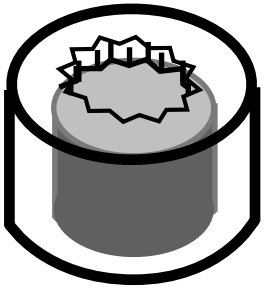
1. Construction Bricks

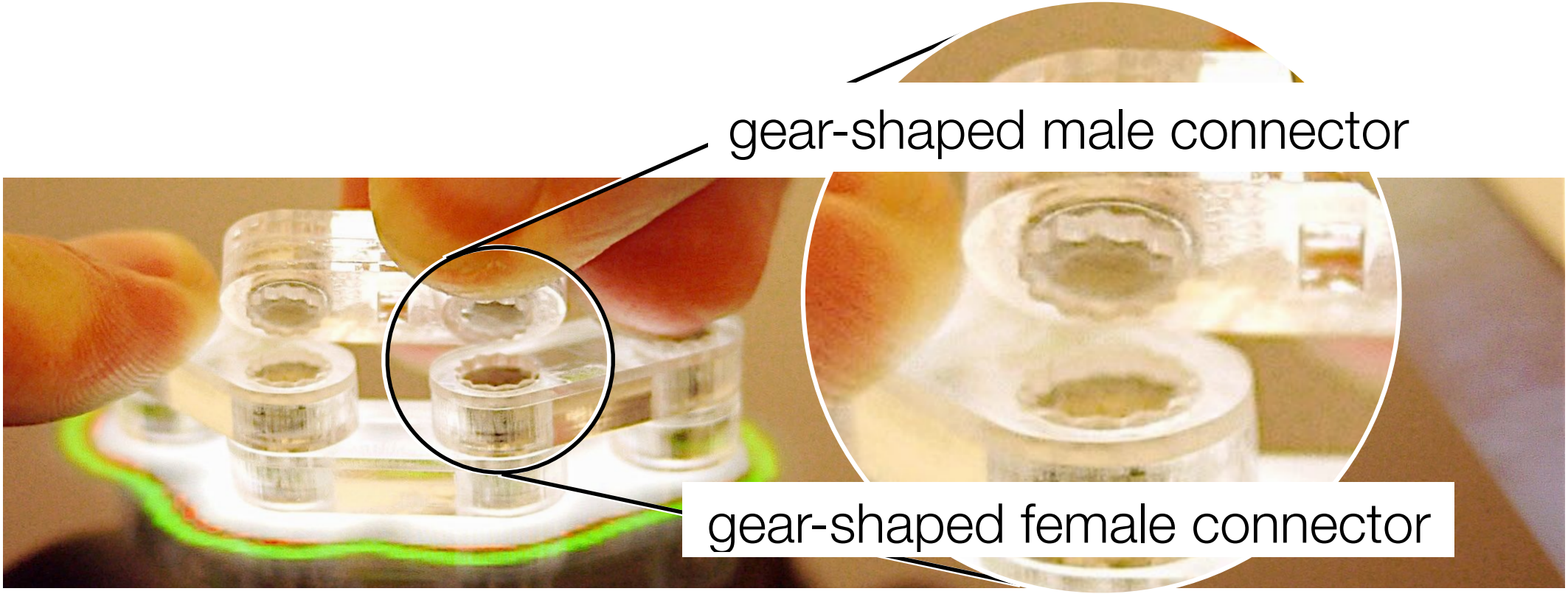
for addictive construction



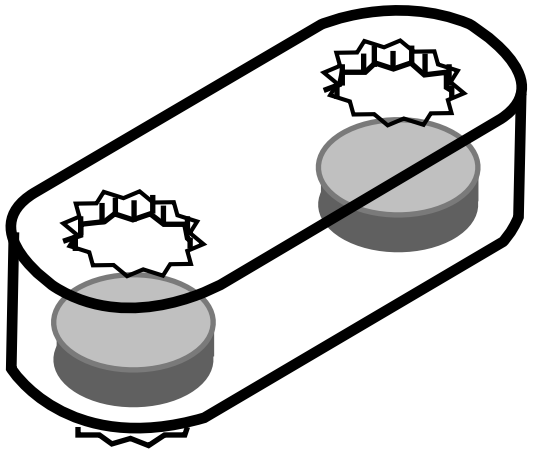
2. Supporting Bricks: for stabilizing structures

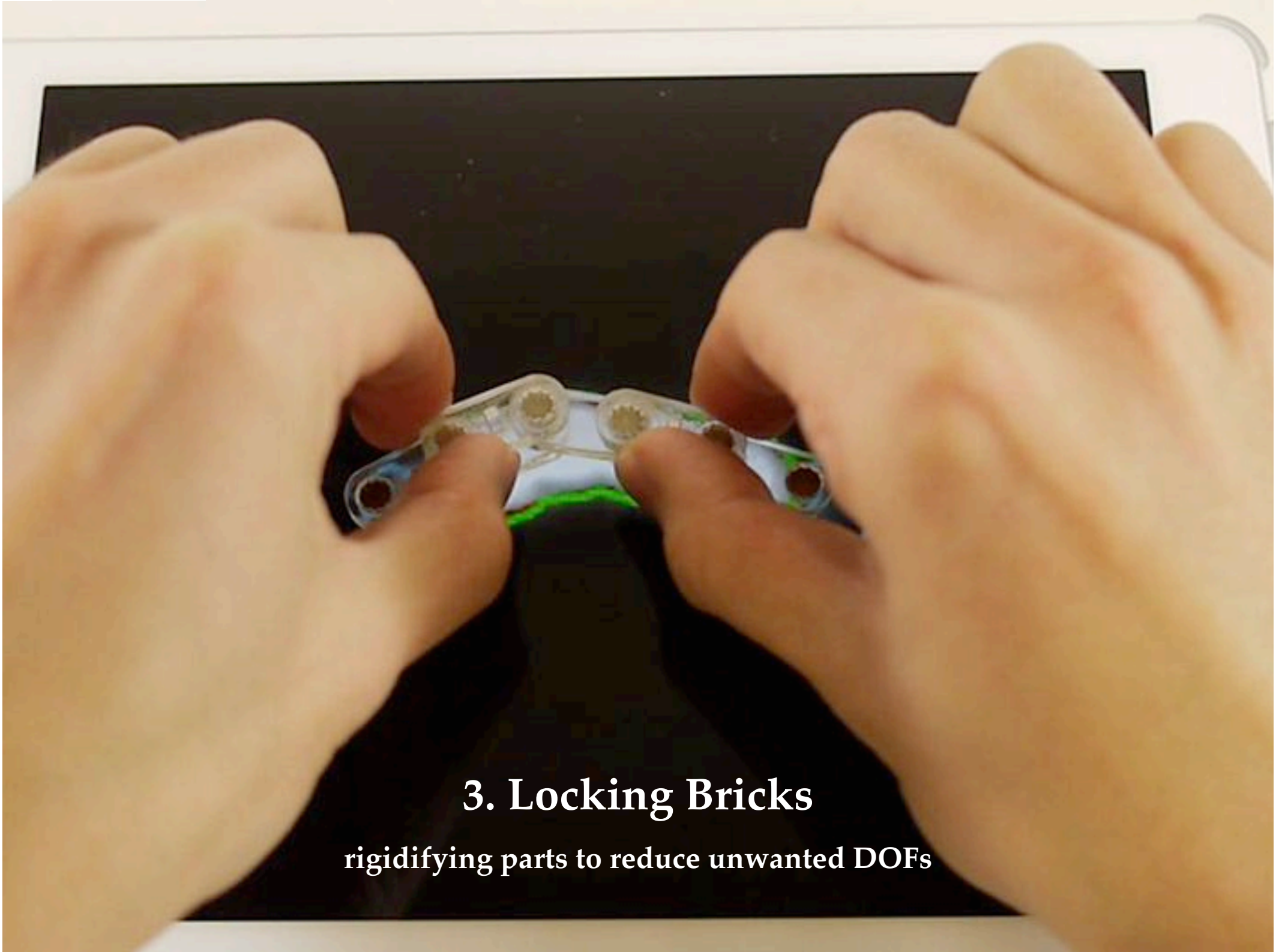
(1x1 construction bricks)





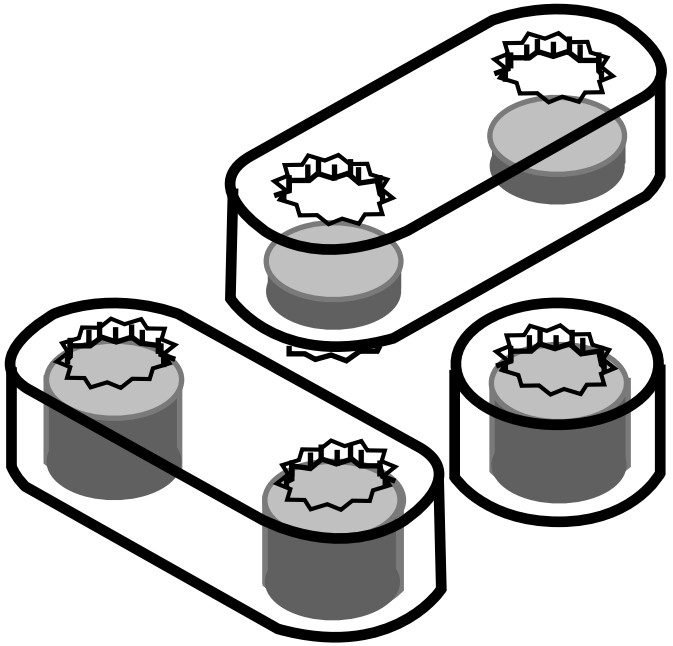
3. Locking Bricks: reduce unwanted DOFs by locking joints





3. Locking Bricks

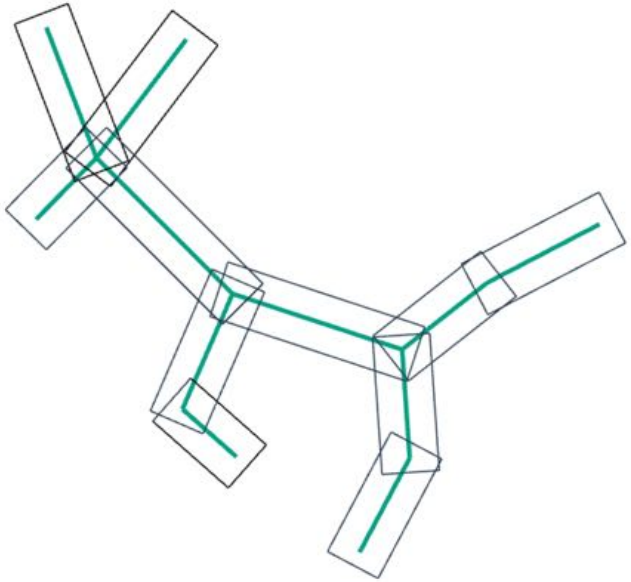
rigidifying parts to reduce unwanted DOFs



Simple, **Stable**, and **Transparent** in use.

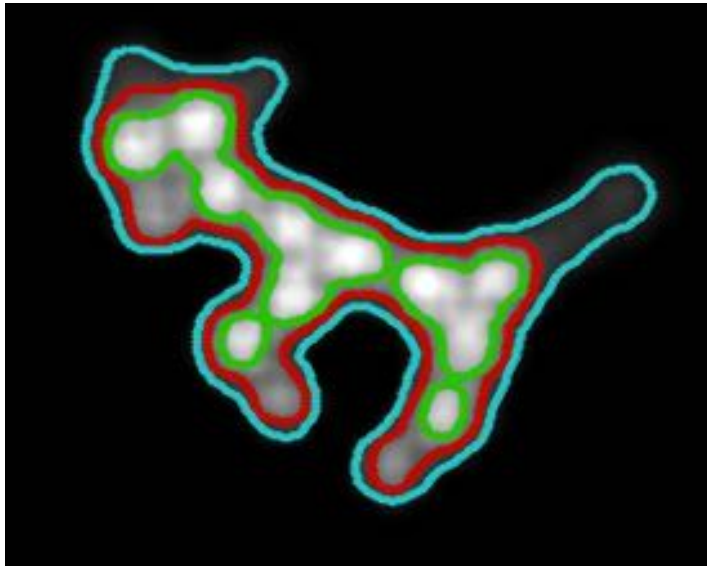
Geometry

Skeleton



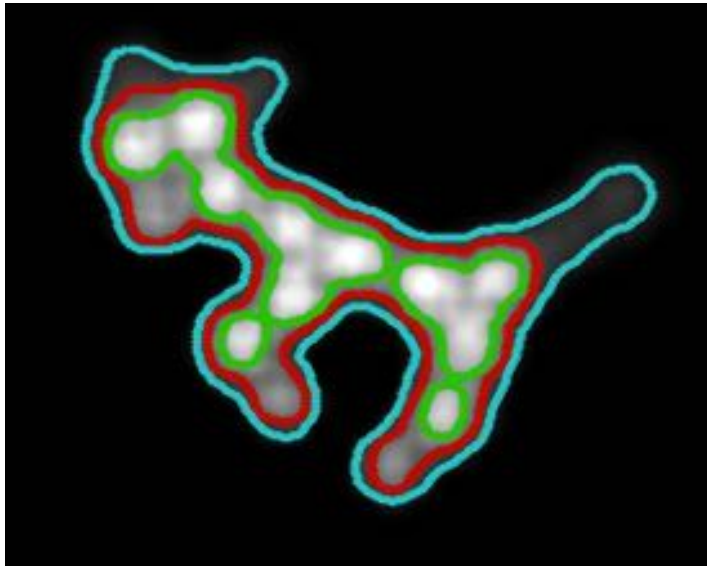
Sensing Algorithm

Geometry



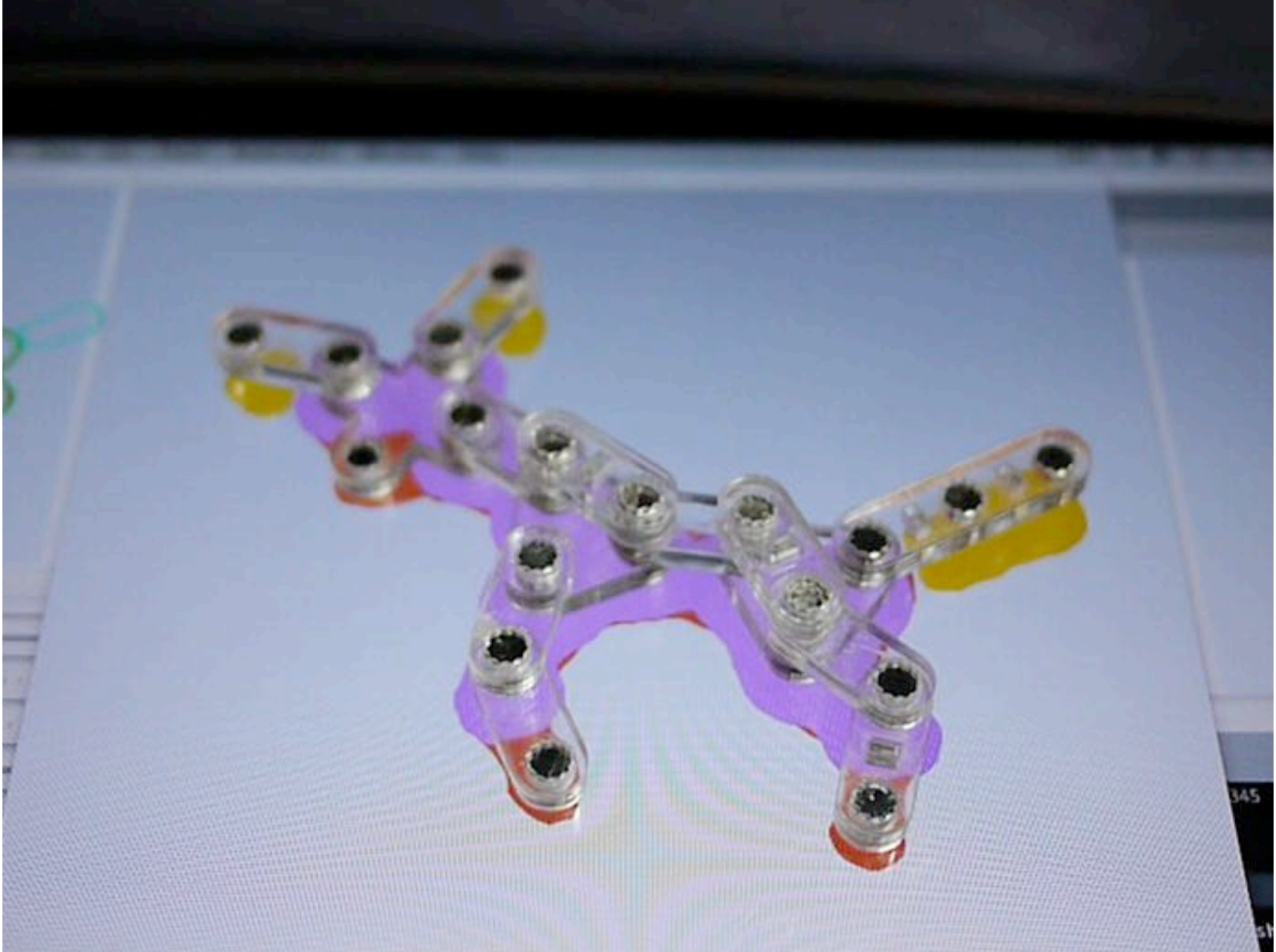
1. contour extraction

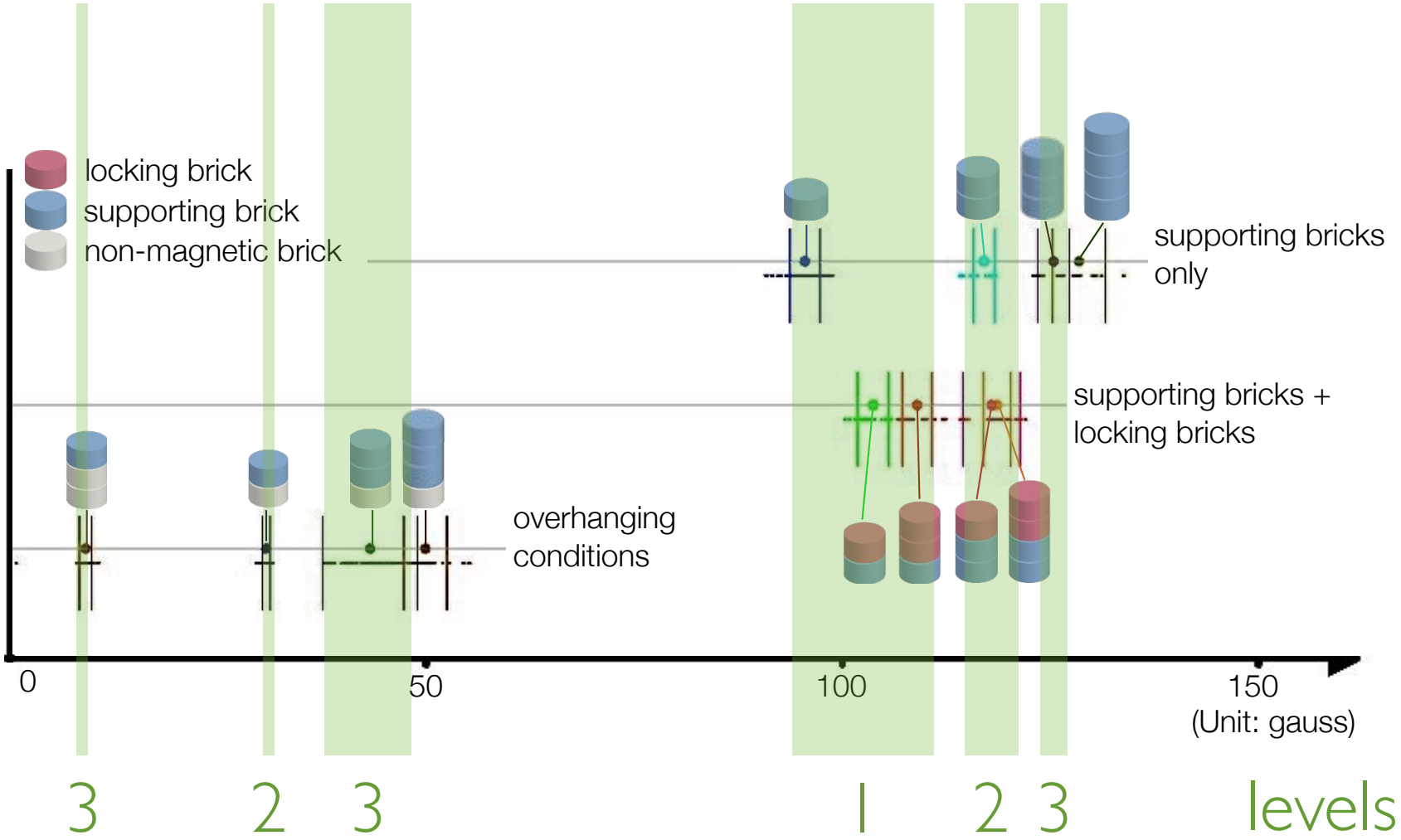
Geometry



2. segmentation

not stacked stacked overhanging

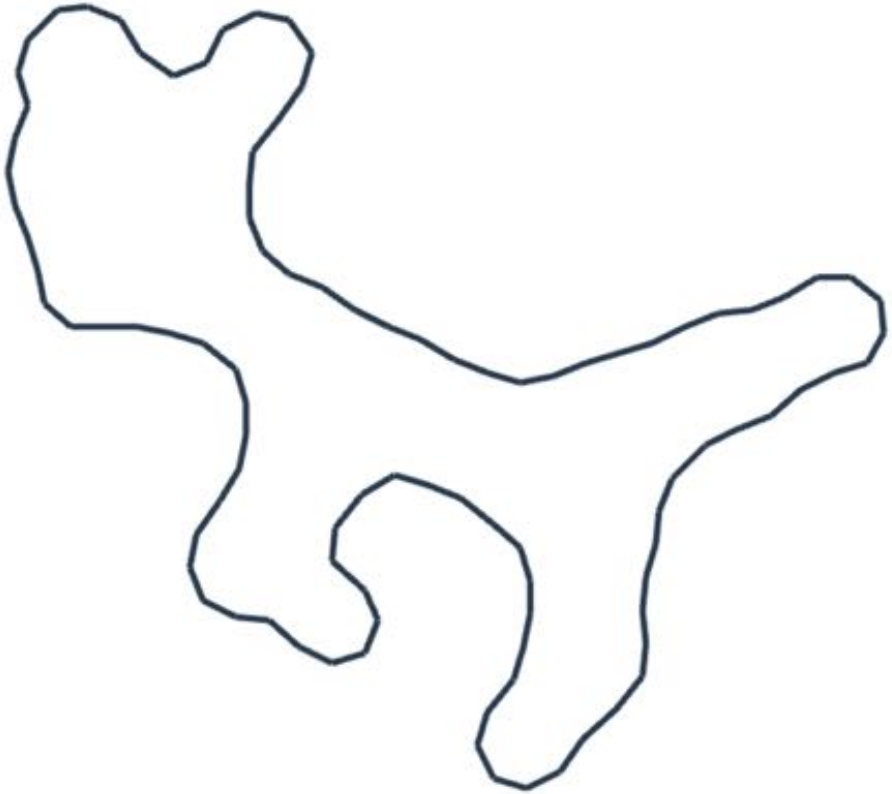


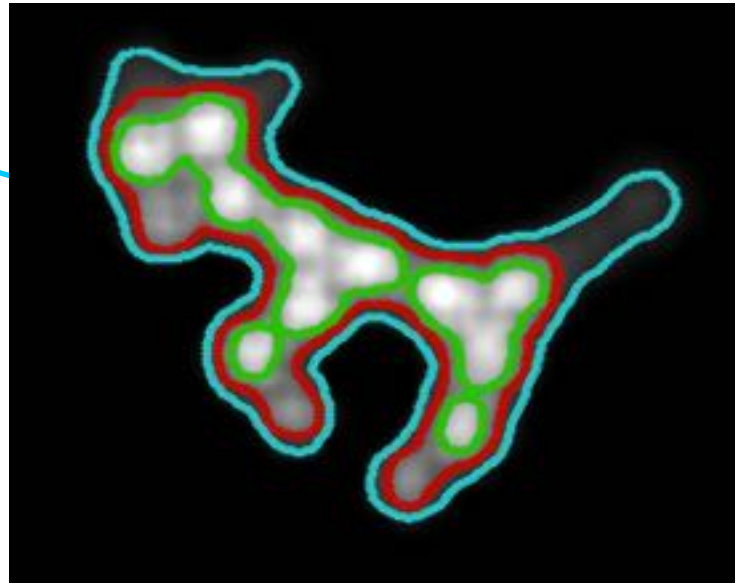


Resolves 3D structures in maximum 3 levels of stacking

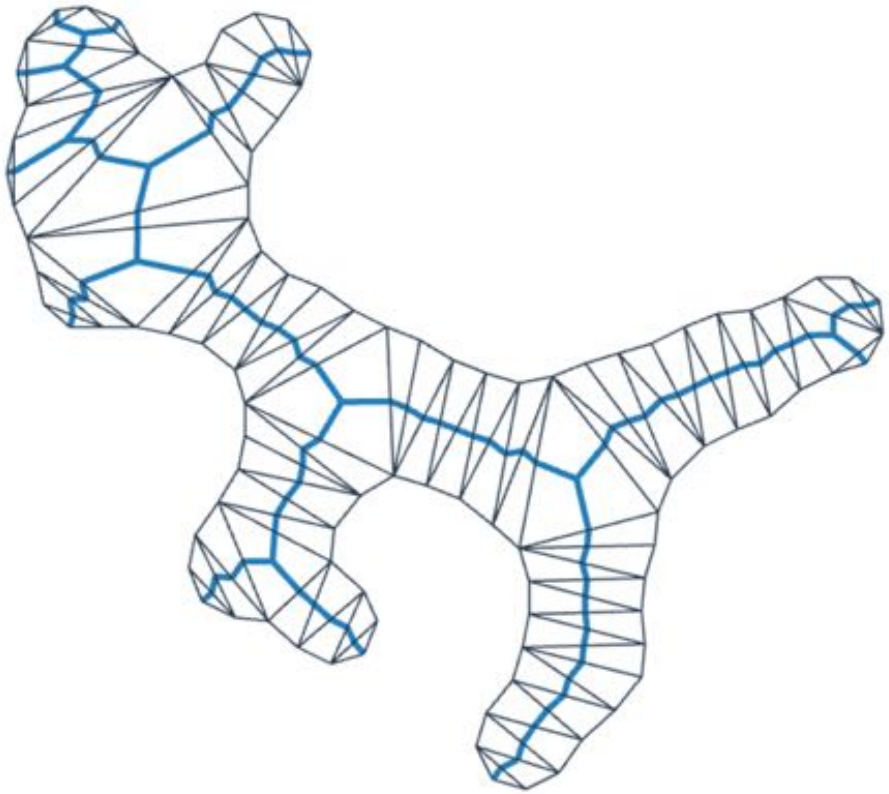
The uses of *locking bricks* do not affect sensing.

Skeleton





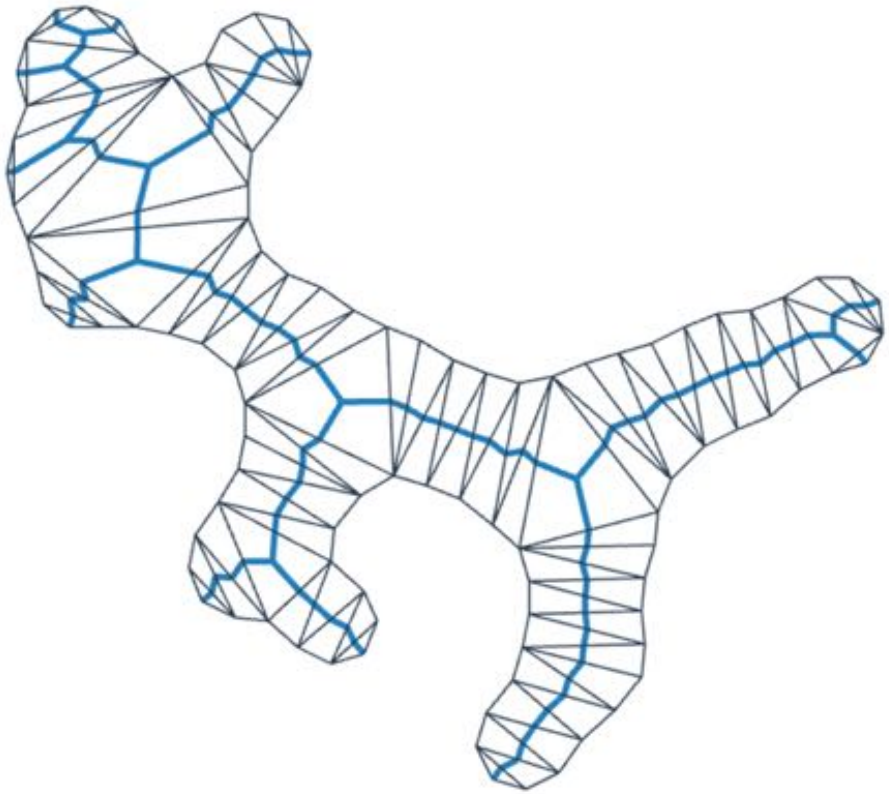
Skeleton

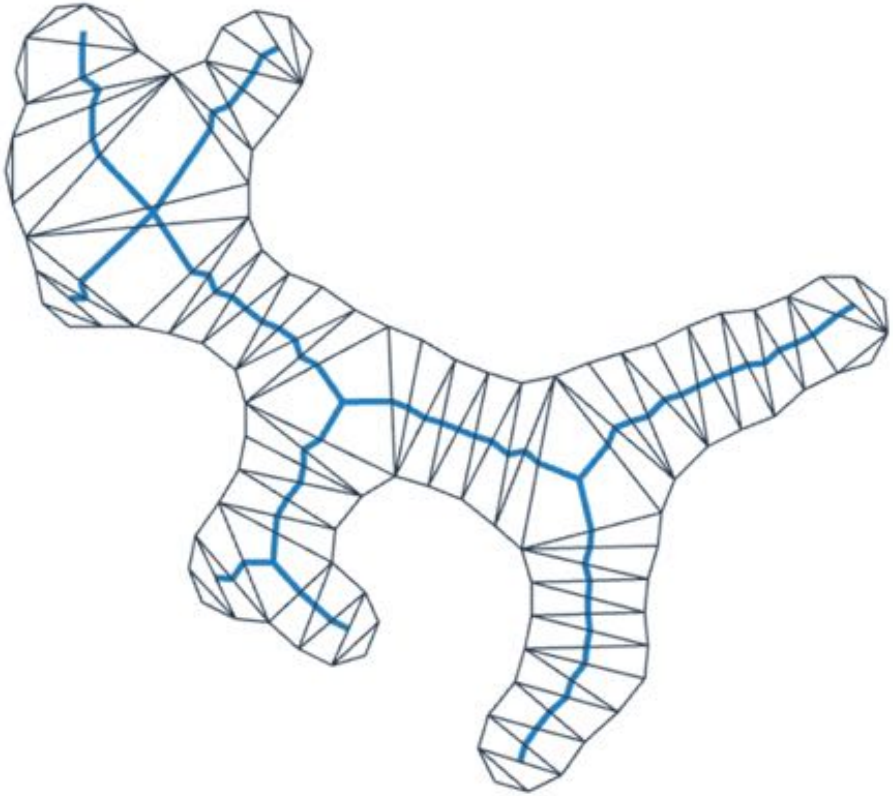


1. spine extraction

Using Constrained Delaunay Triangulation

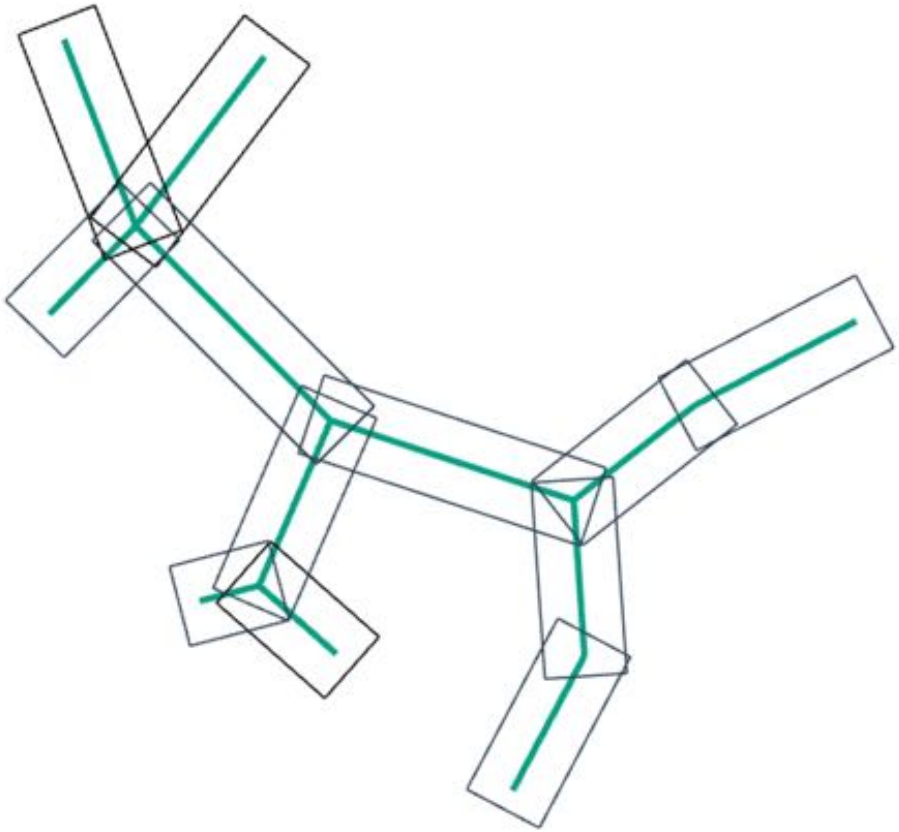
Skeleton

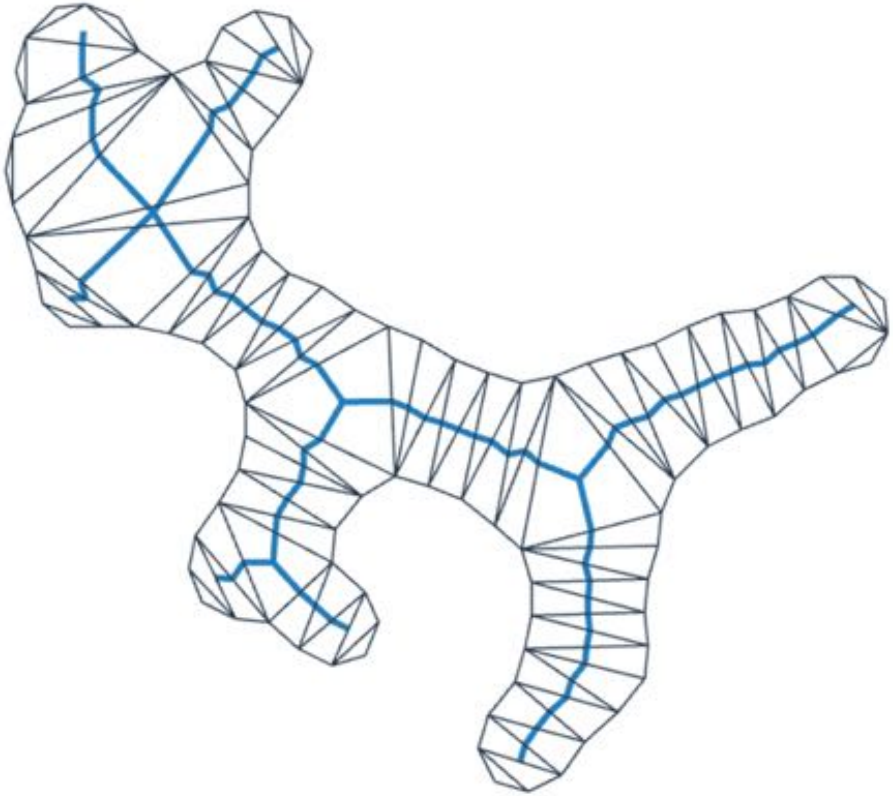




2. trimming and merging

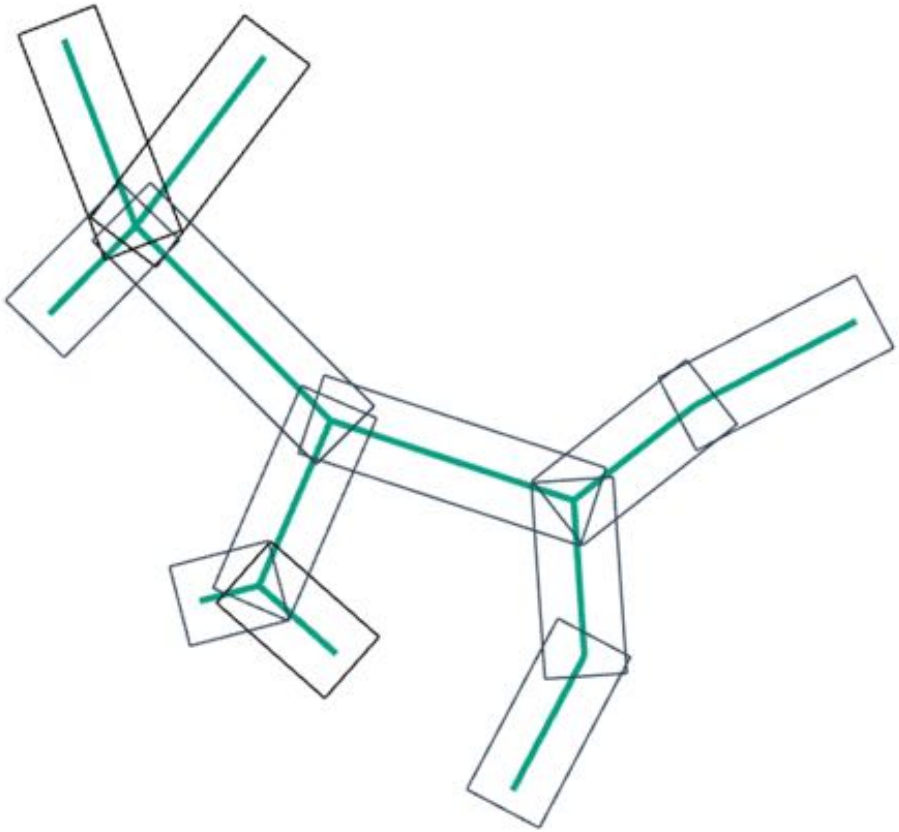
Skeleton

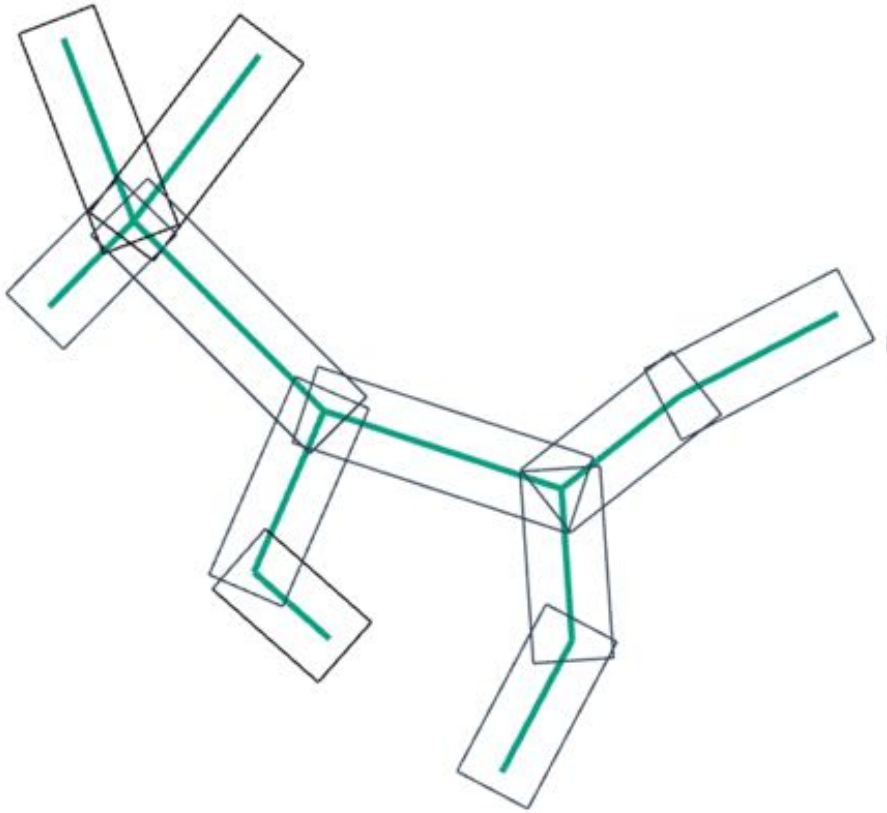




3. simplifying

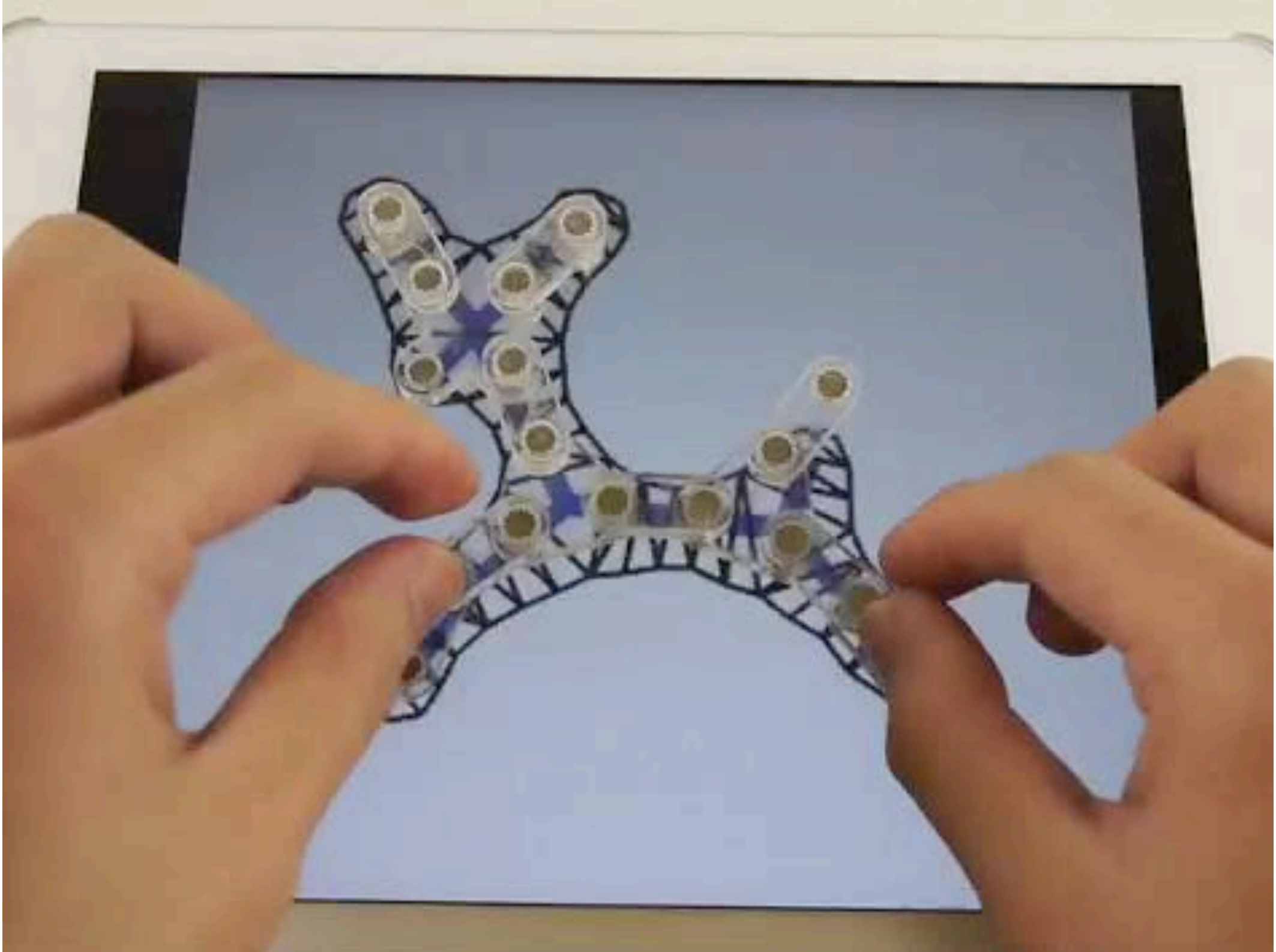
Skeleton

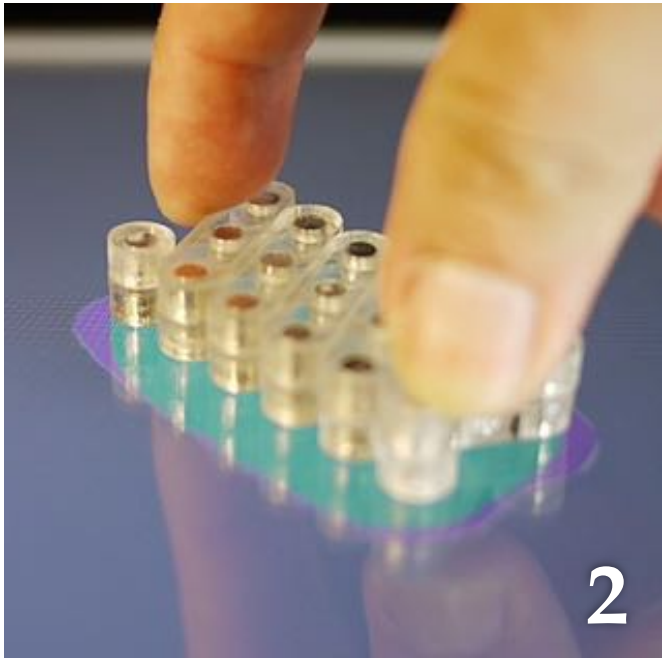


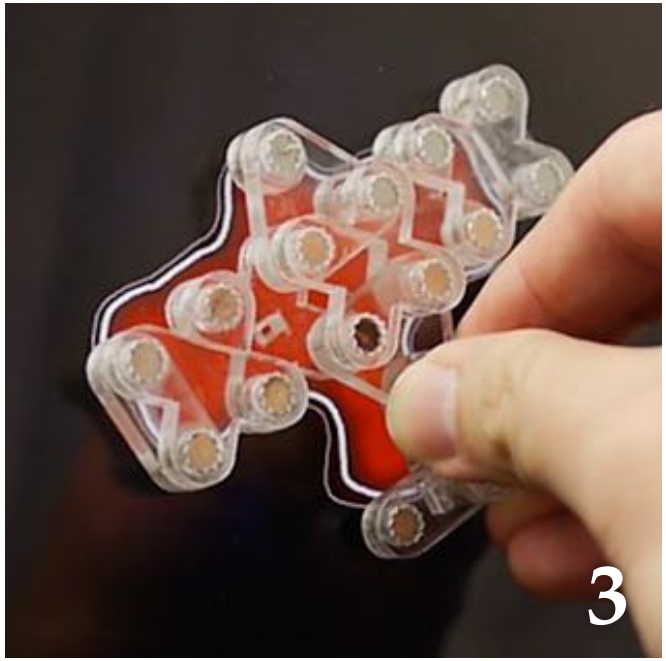


4. trimming

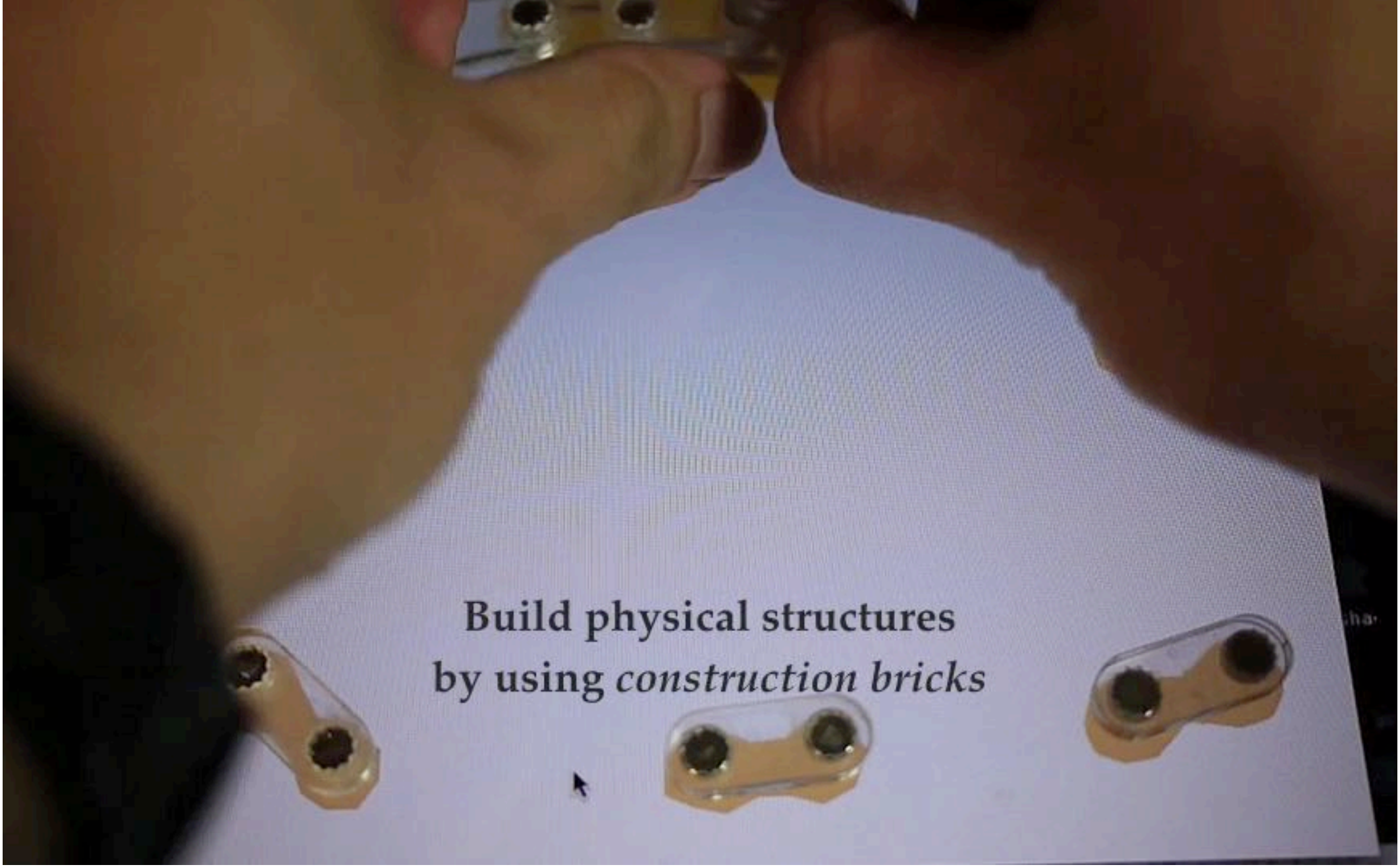
Result



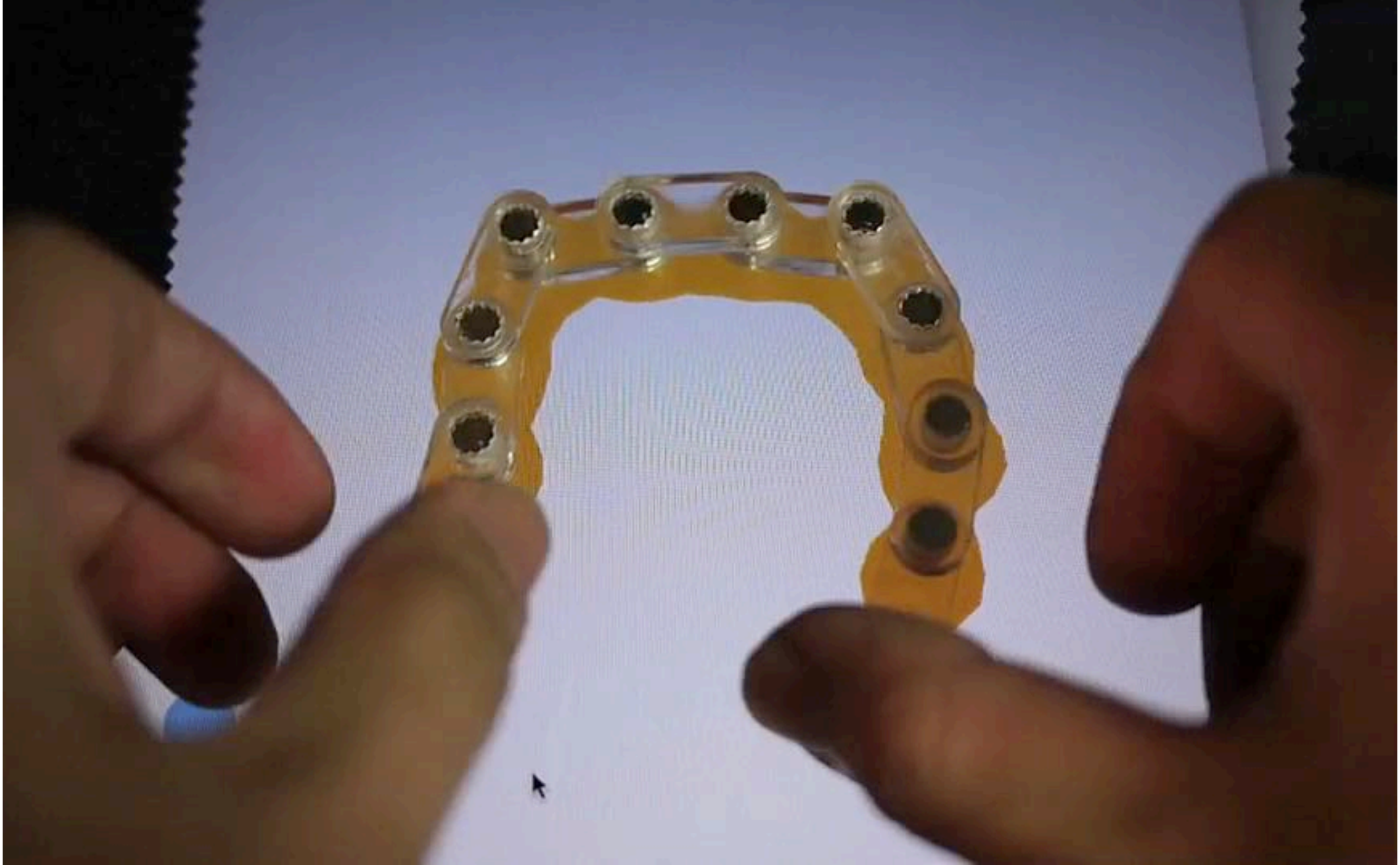




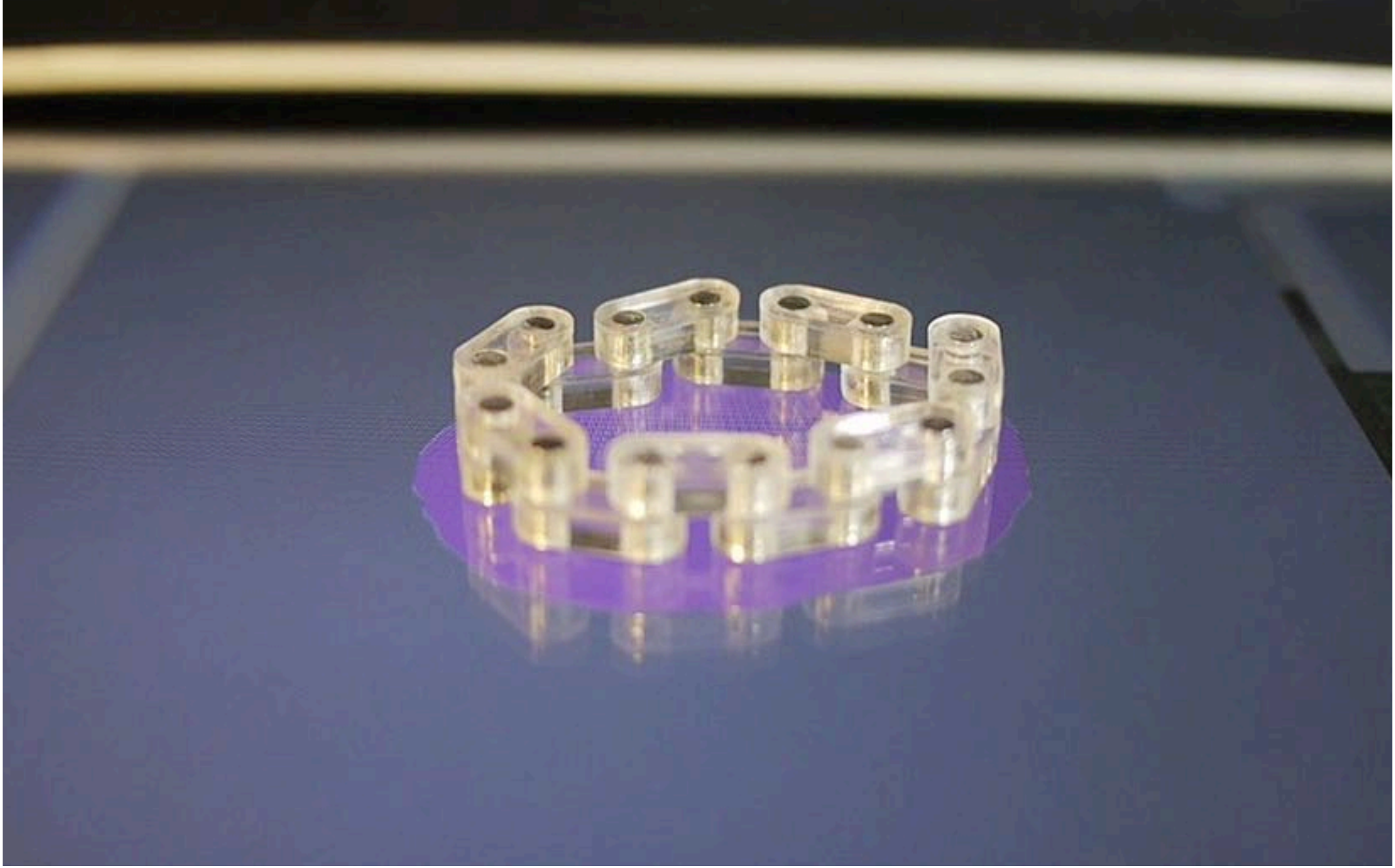
Basic Utilities of the Magnetic Building Blocks



1. Interactive Form Construction and Manipulation

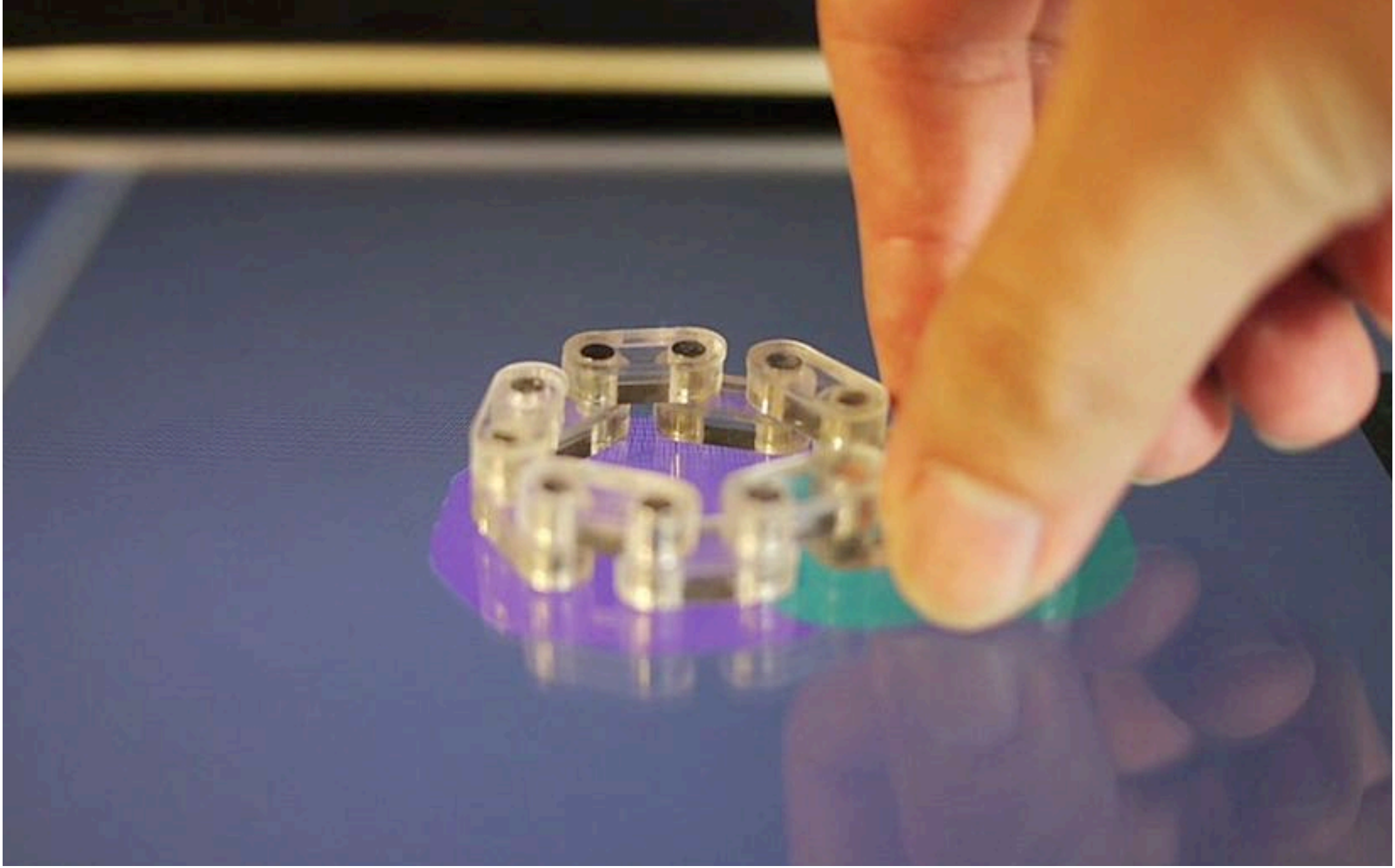


1. Interactive Form Construction and Manipulation



2. Constructing Elastic Physical Structures

by utilizing repulsions and attractions



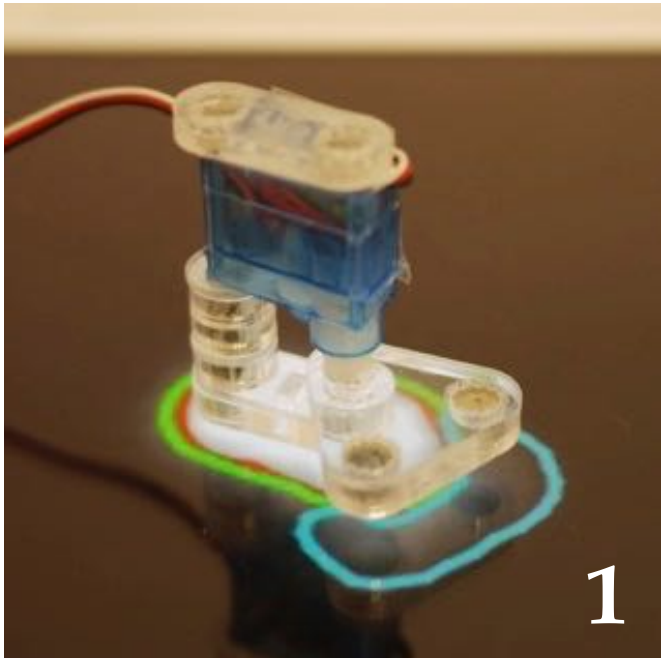
2. Constructing Elastic Physical Structures

by utilizing repulsions and attractions

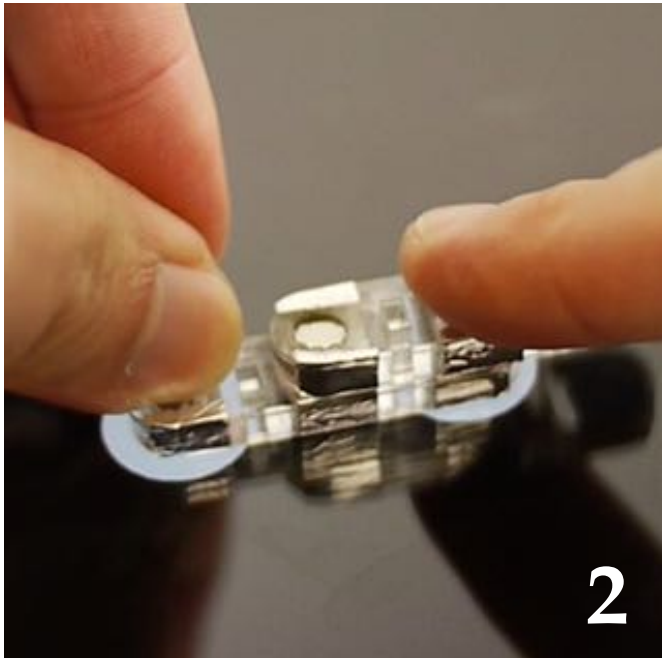
3. Constructing Controllers for Near-Surface Interactions

3. Constructing Controllers for Near-Surface Interactions

Actuation brick

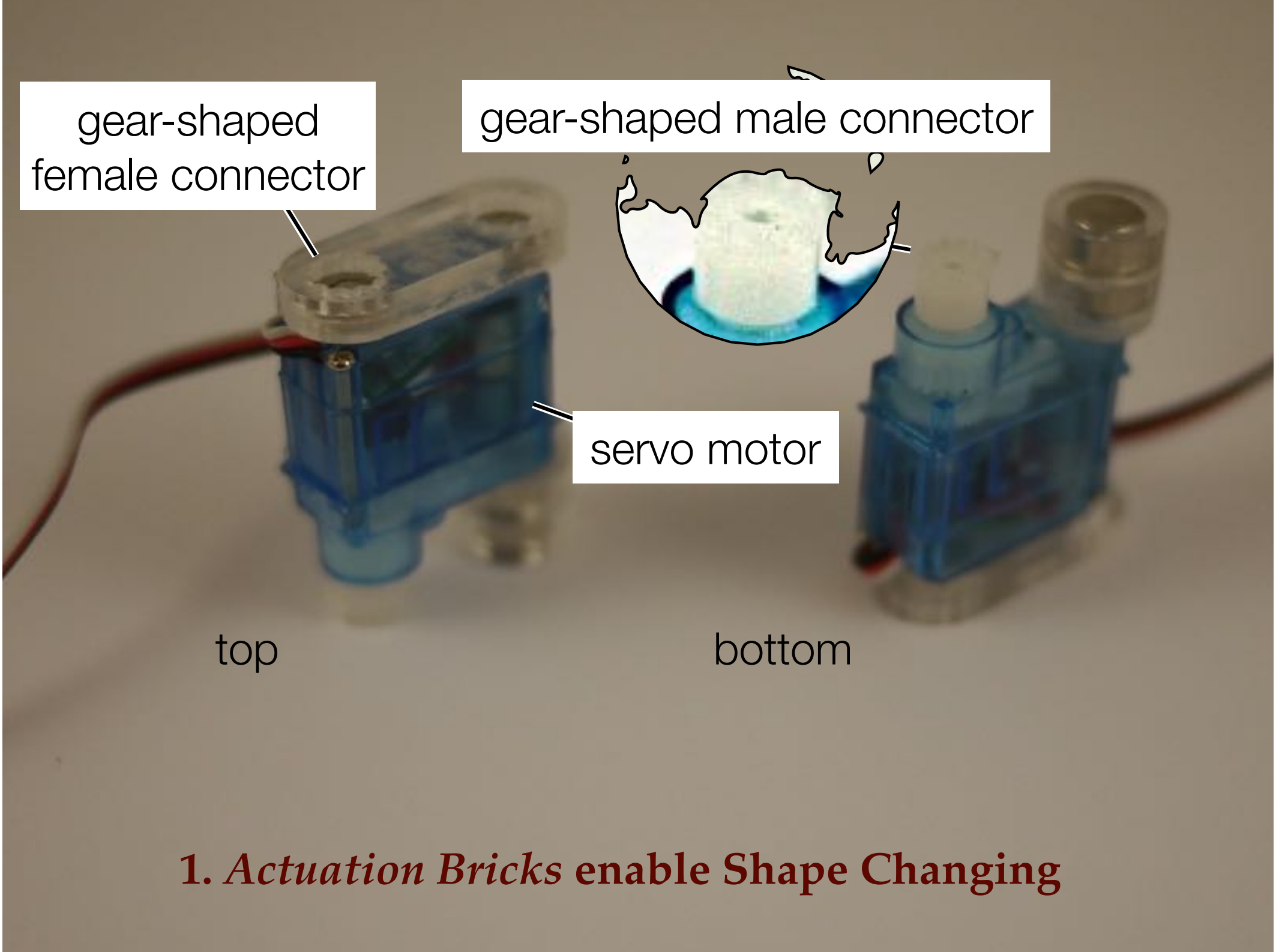


Touch brick

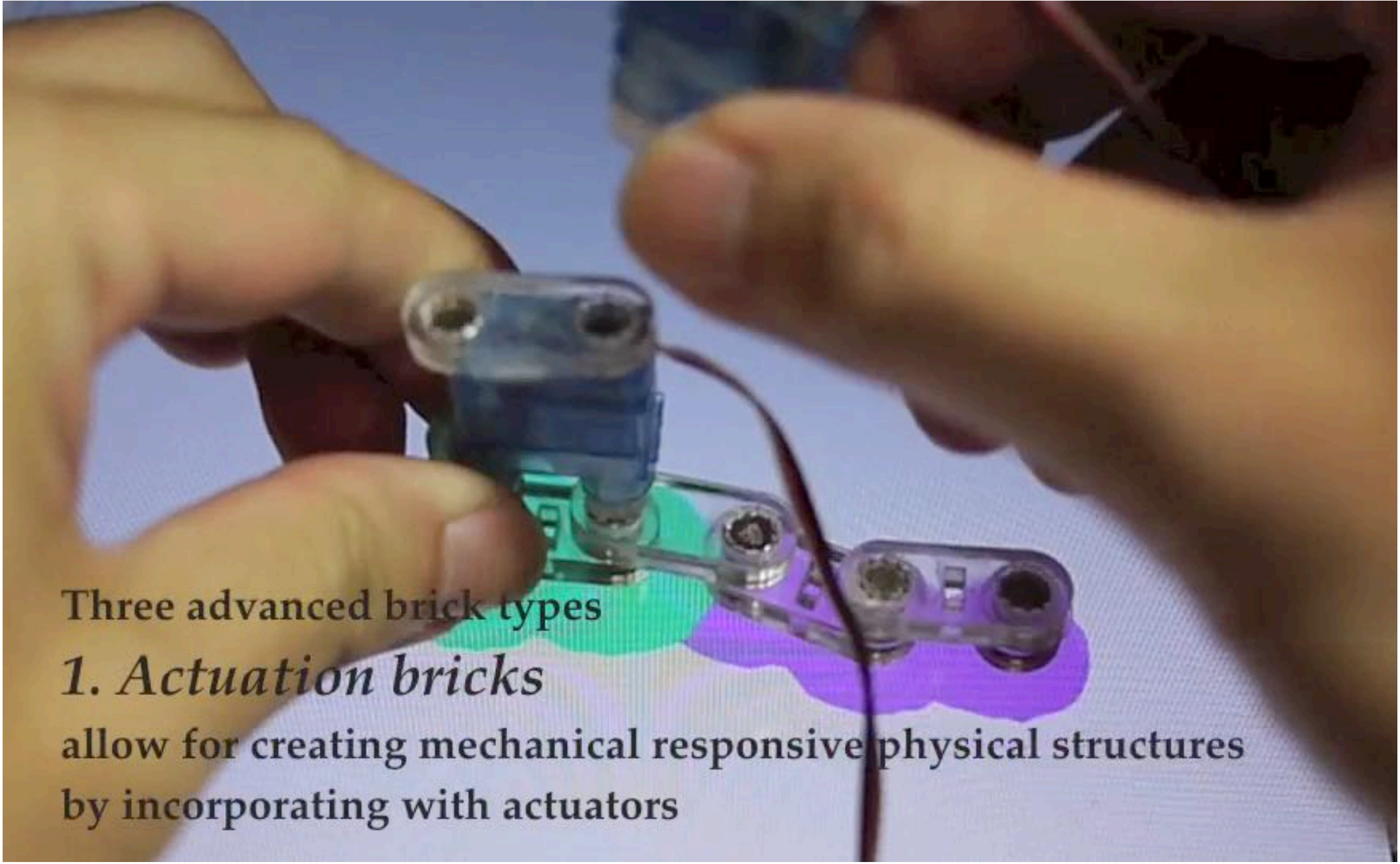


Optic brick

Extending GaussBricks for More Interactivity



1. *Actuation Bricks* enable Shape Changing



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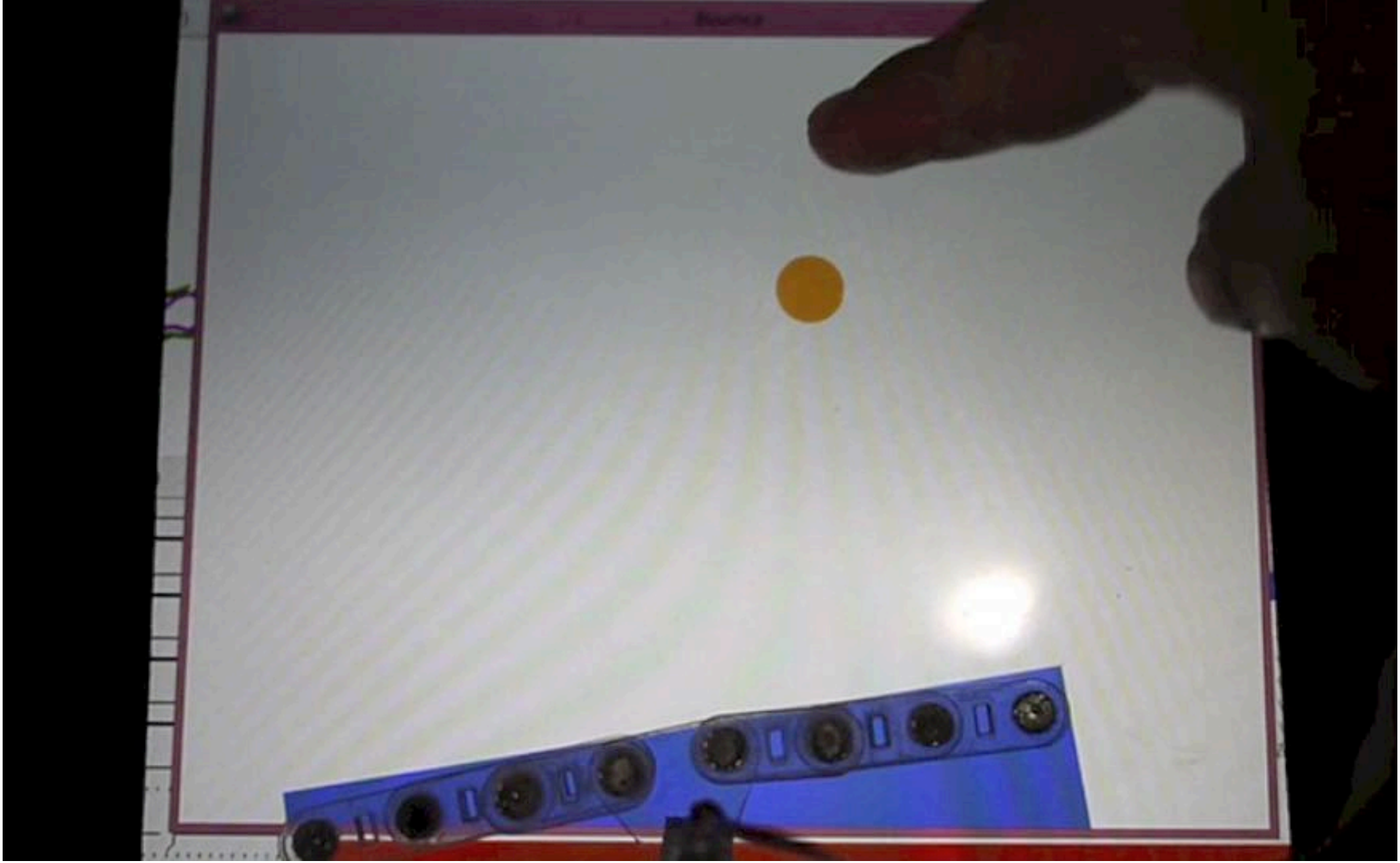
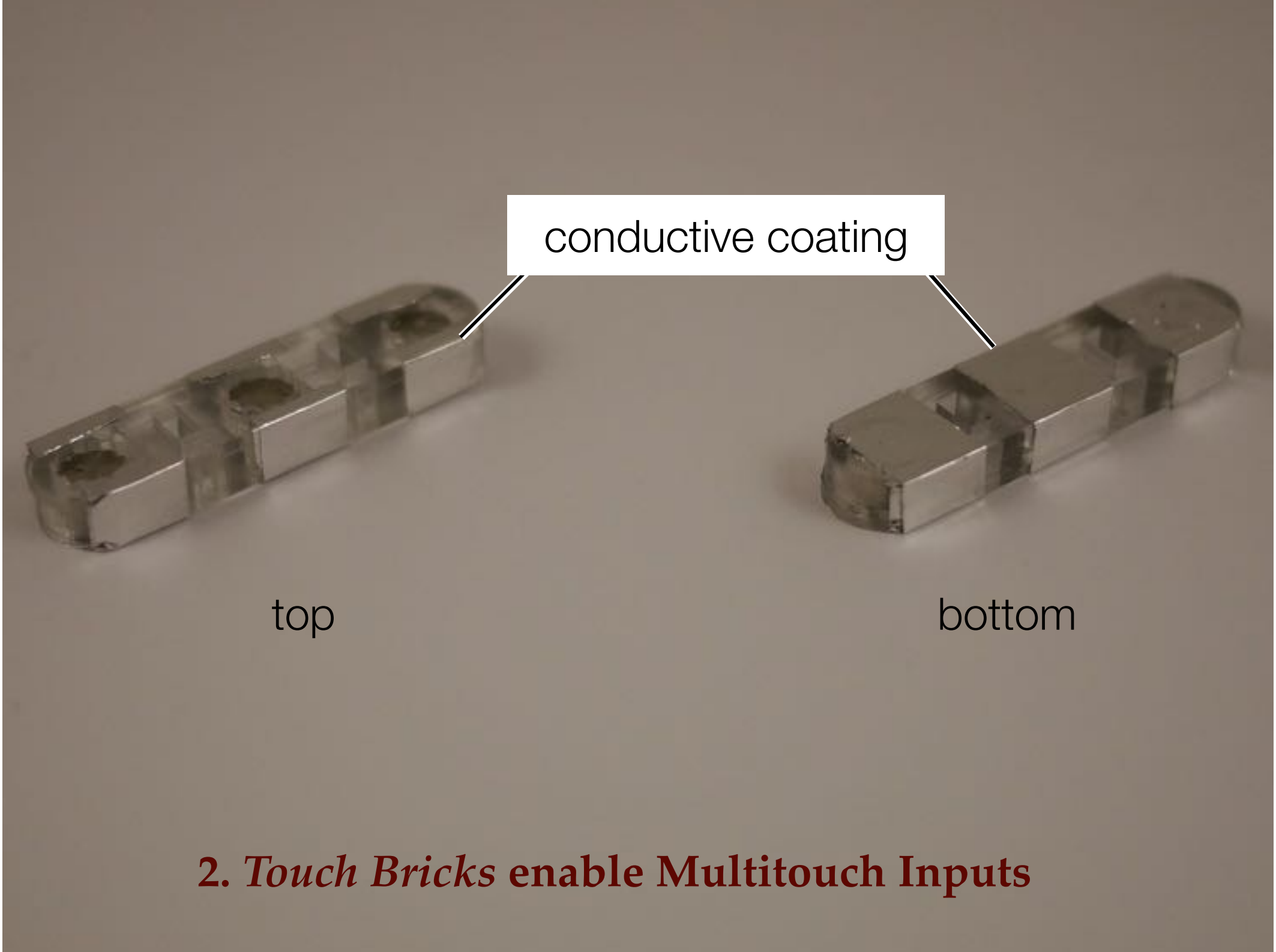
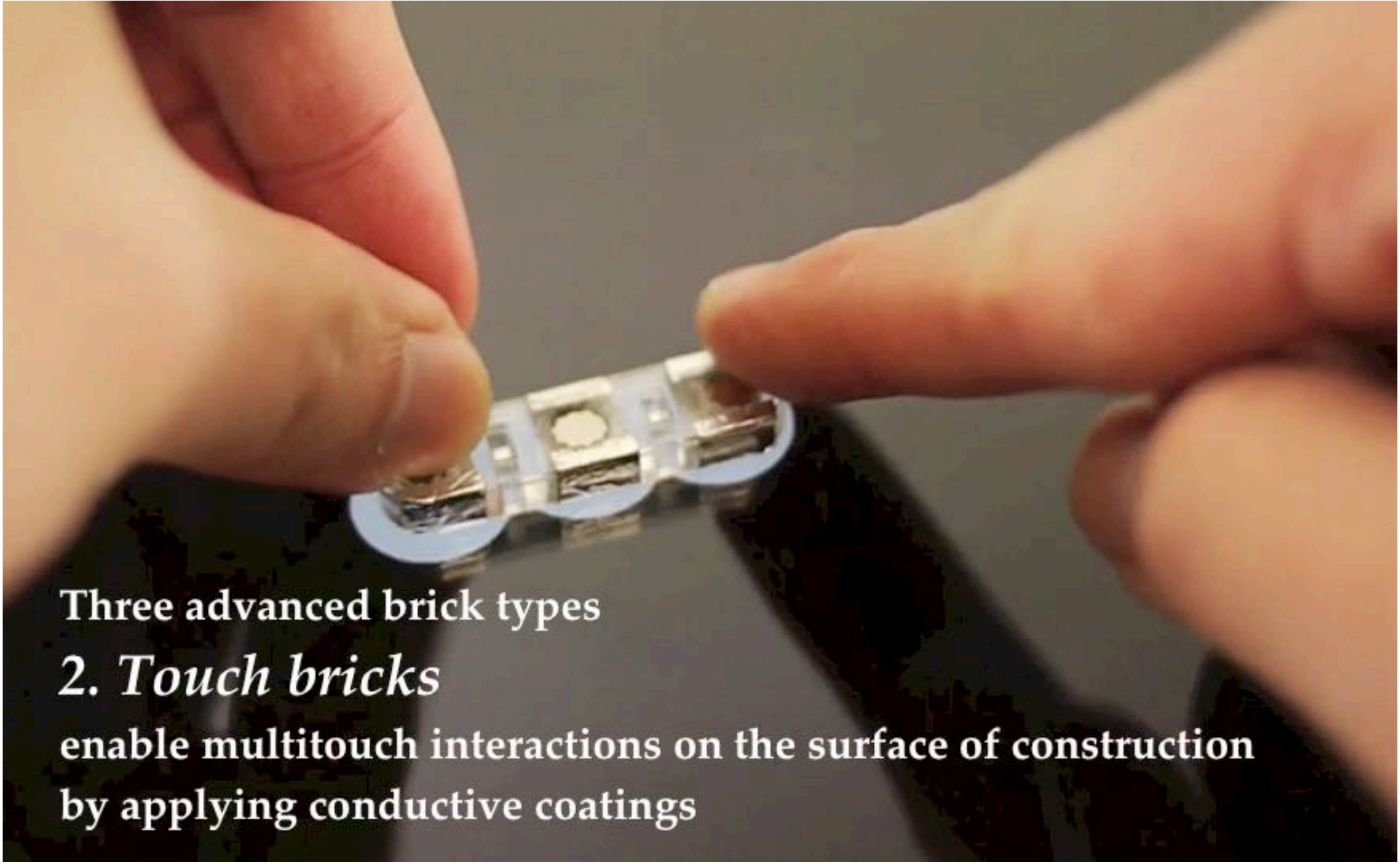


1. *Actuation Bricks* enable Shape Changing



2. *Touch Bricks* enable Multitouch Inputs



2. *Touch Bricks* enable Multitouch Inputs

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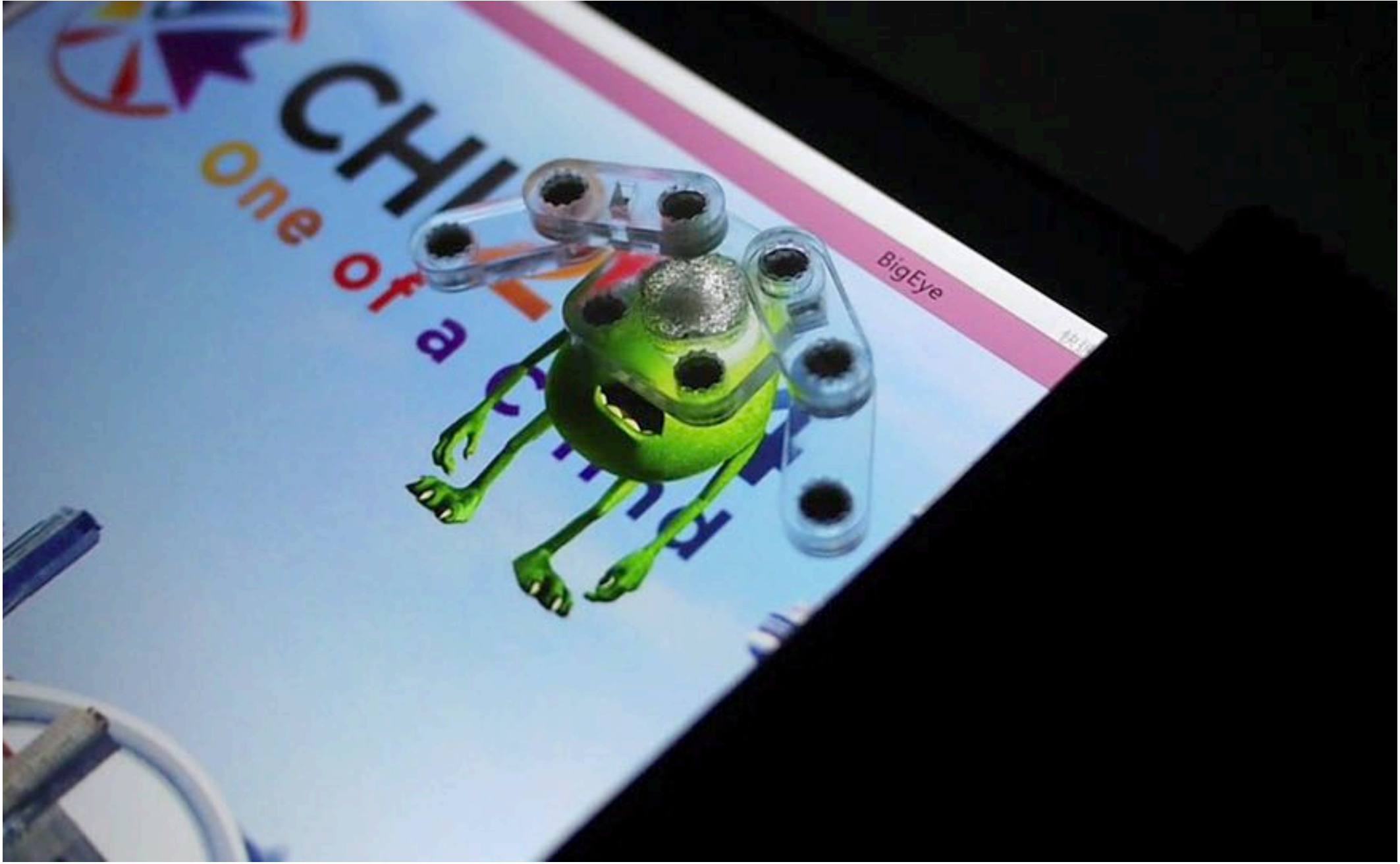
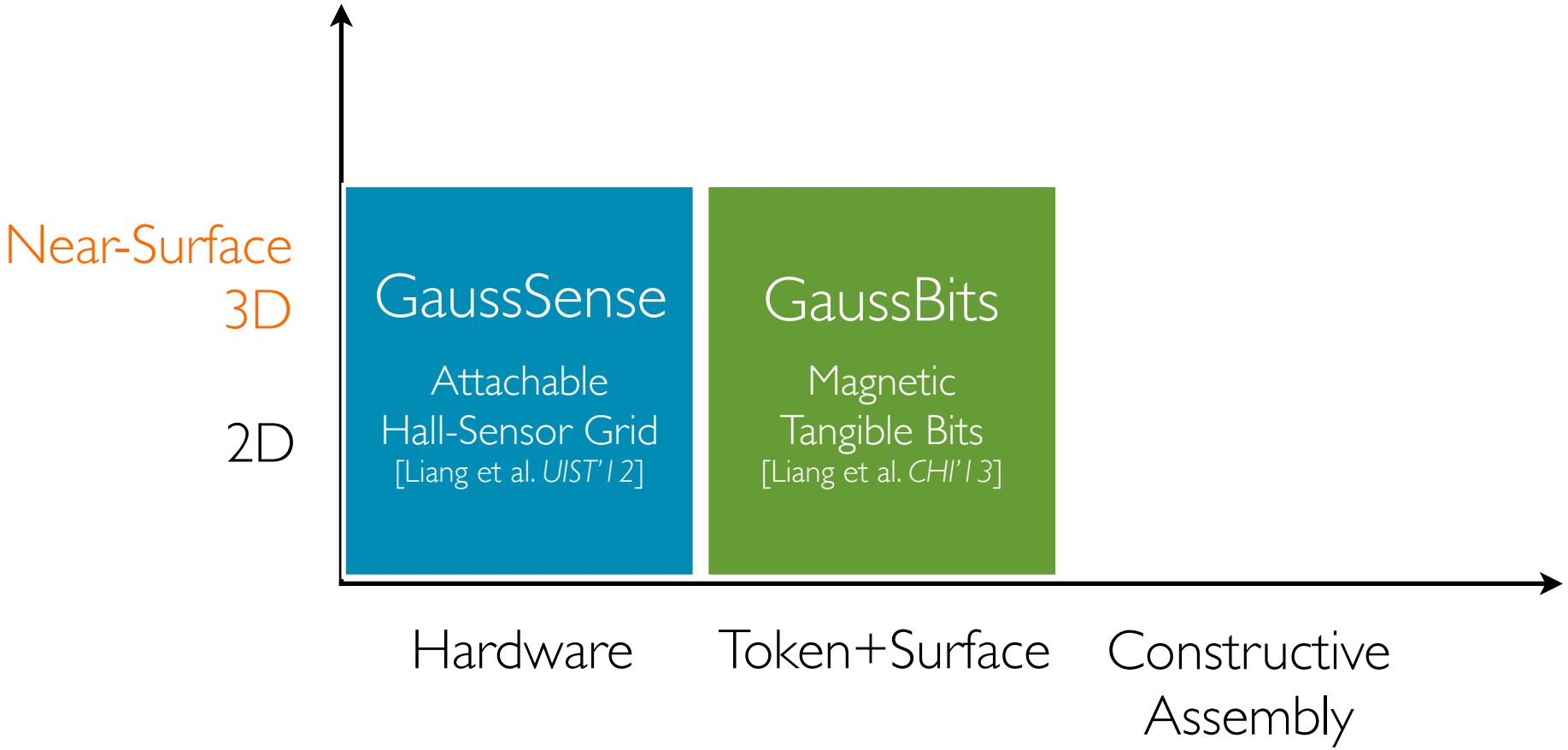
3. *Optic Bricks* enhance Display Capability



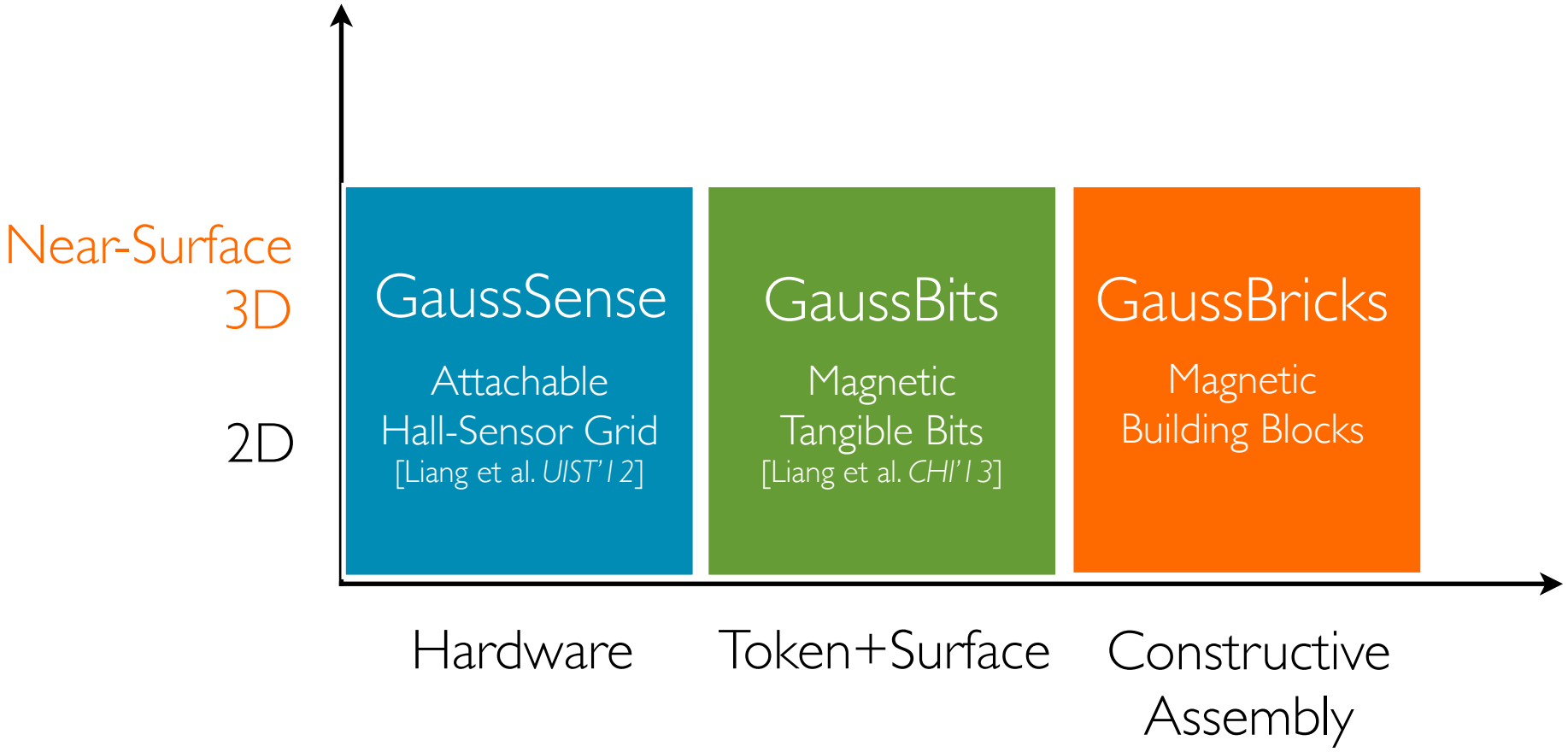
3. *Optic Bricks* enable Display Capability

Conclusion



TUI Design Space** of **Portable Displays

Magnetic Building Blocks for Supporting **Constructive Tangible Interactions** on Portable Displays



TUI Design Space** of **Portable Displays