

12

Haptic Devices

Human Computer Interaction

COMS21301

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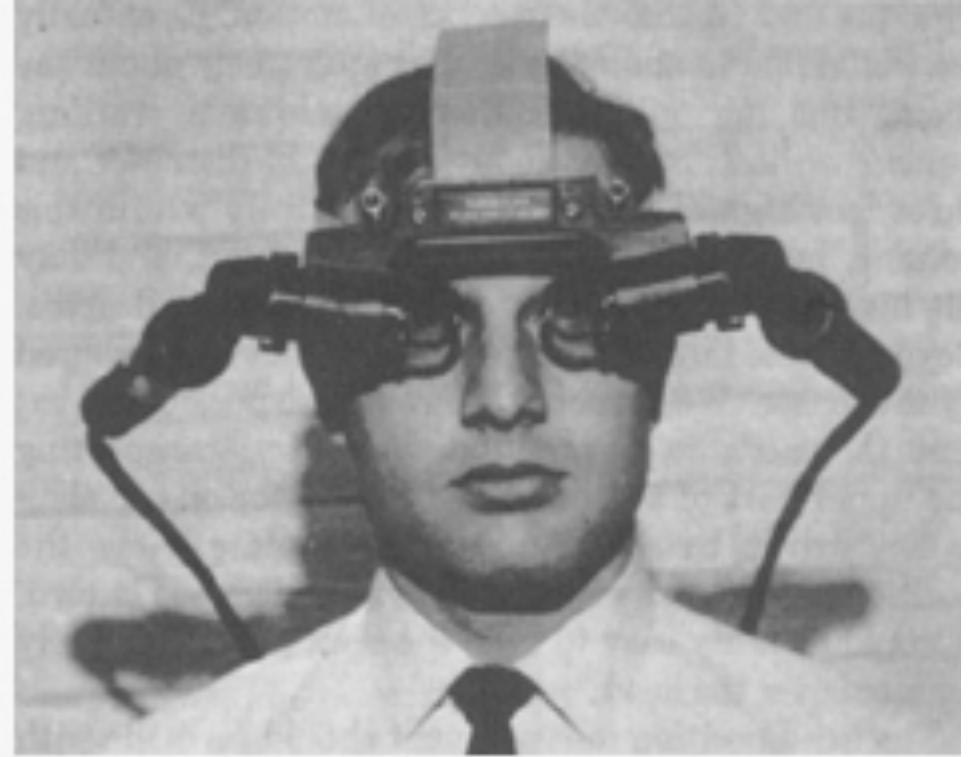
this is the level of interaction realism **people have been
dreaming of**

... we are not there yet



where realism/immersion can come from?

Step 1: **surround** users with **graphics**...



1968 head-mounted display
Ivan Sutherland

head-mounted VR hit “mainstream” **in the 80s**



problem of all HMDs:
users could not see their **own bodies**



CAVE brought bodies back (1993)

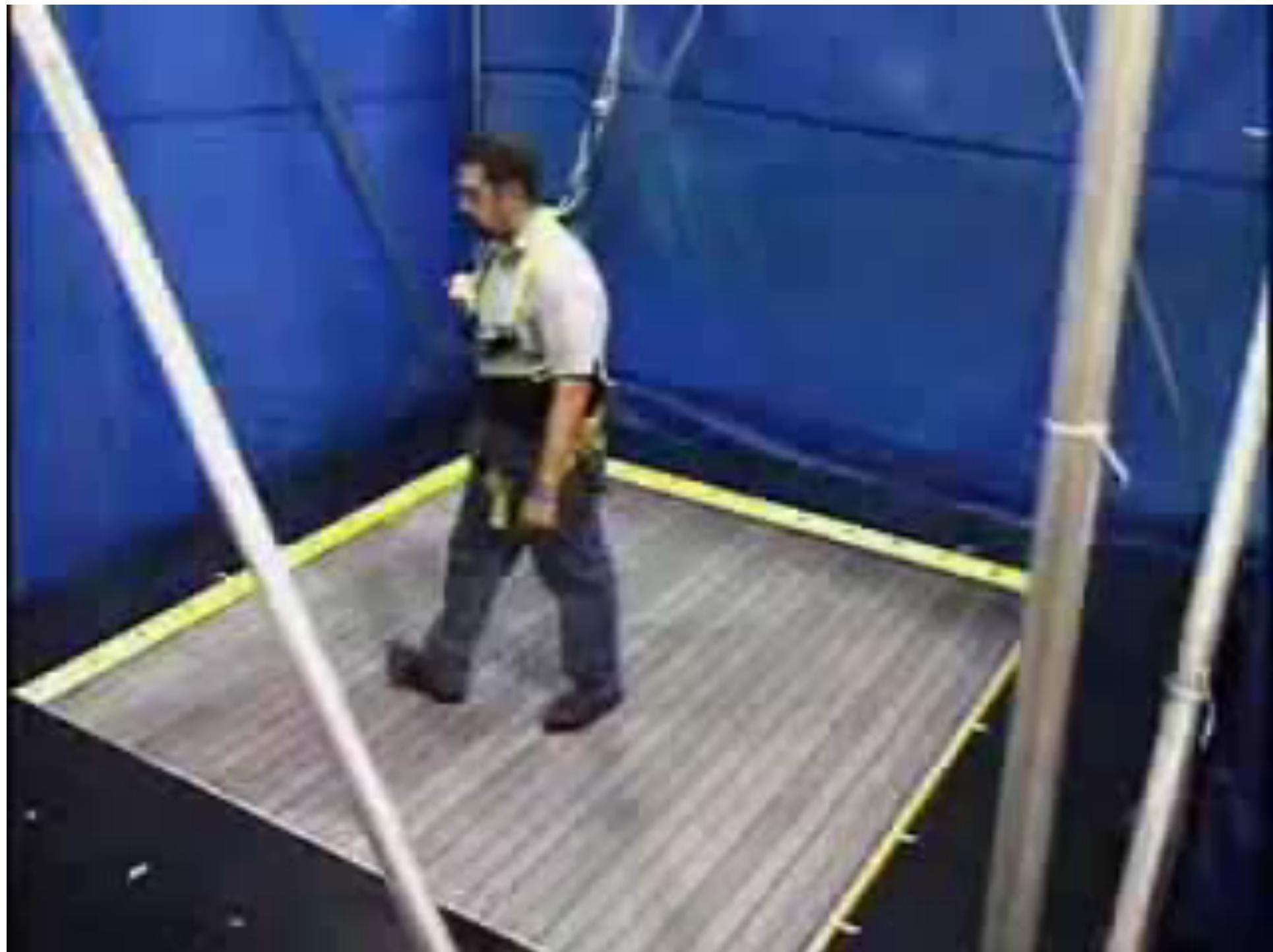


despite allowing users to see their own bodies,
CAVE had **two main limitations...**



users can walk, but the virtual world is finite,
soon users hit the “**end of the world**”

→ we can address this with **treadmills and motion platforms**





Bird simulator (siggraph)



when users try to touch the virtual objects their hands
simply pass through → **no sense of touch**



we see 3D, computers see us in 3D (kinect),
but our sense of **touch**, tells us **its not real**

today :: an overview of research projects that try to provide virtual objects with a **realistic sense of touch**

→ if you want to make a realistic system, here are **techniques to borrow from**

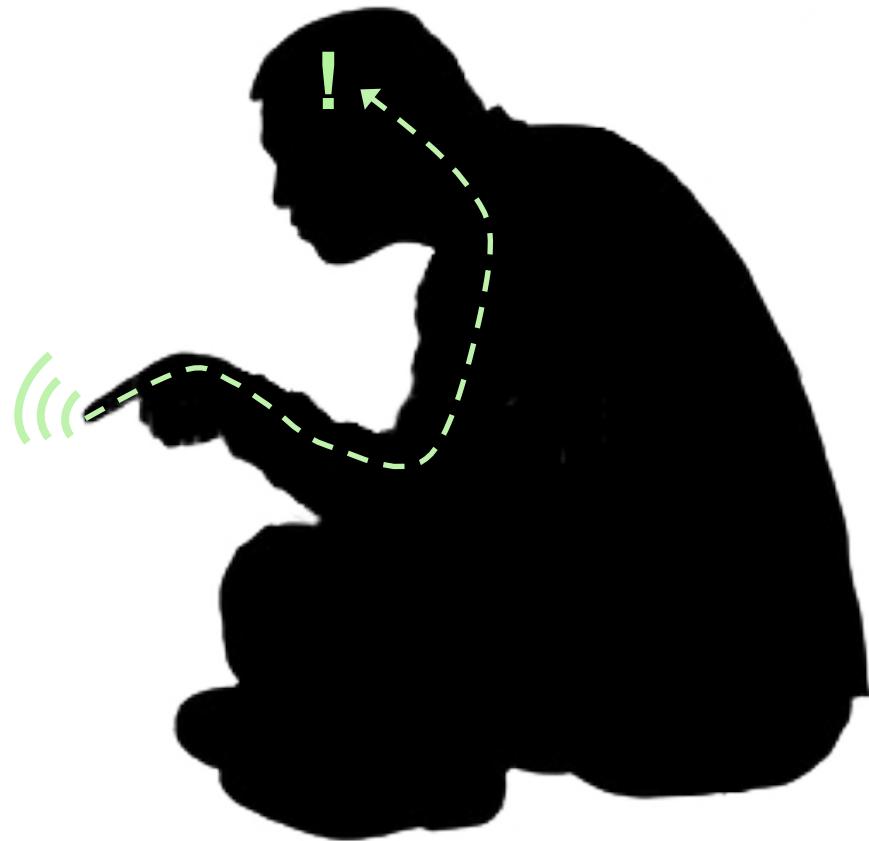
haptics ::

(or haptic technology) is a tactile feedback technology
that **takes advantage of a user's sense of touch**

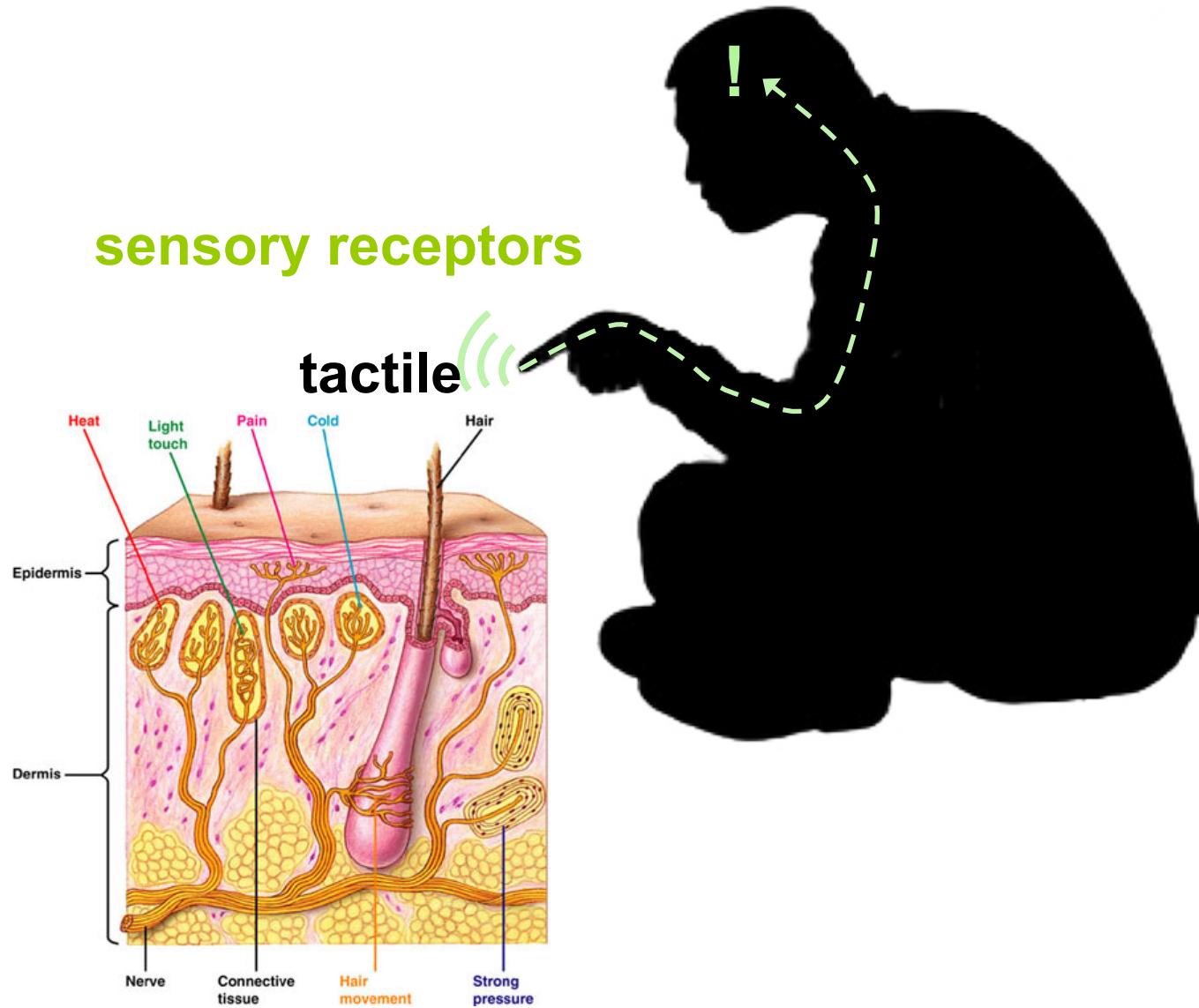
by applying **forces, vibrations, and/or motions to the user**

our haptic
senses

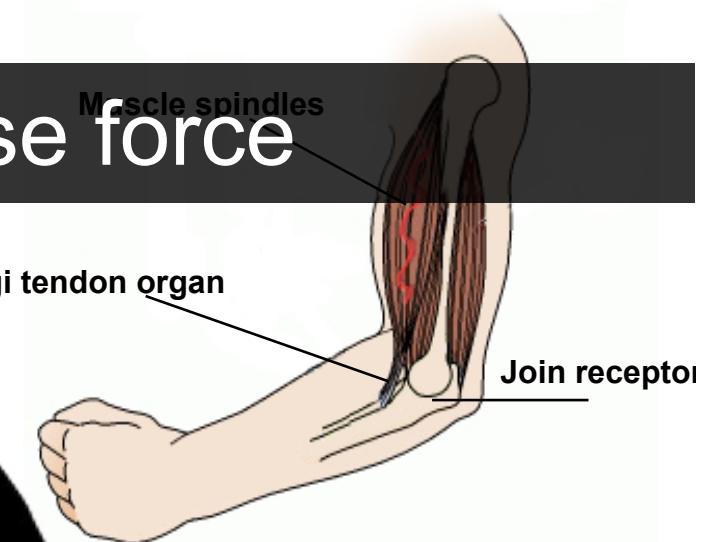
so we want to “fool” a human sense...
what is that sense?



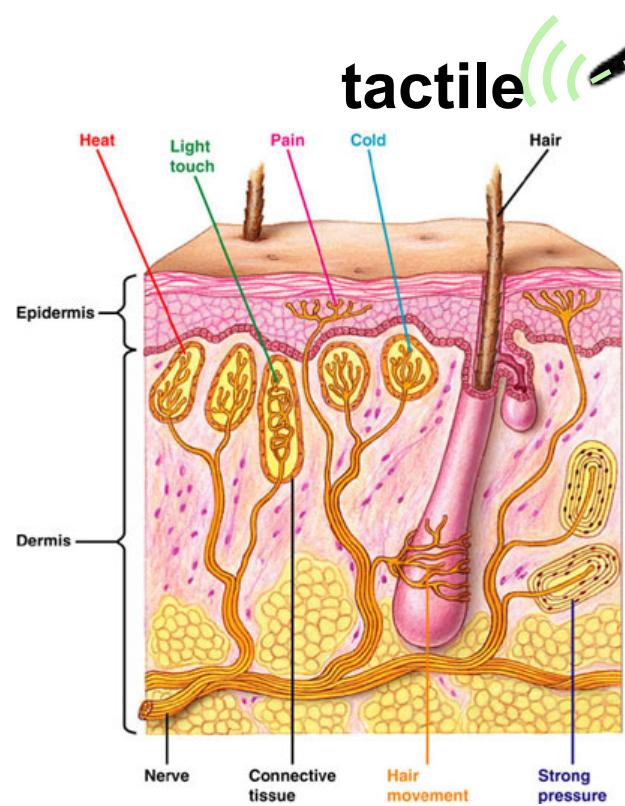
light touch → **skin** has **tactile** sensations



strong touch → muscles sense force



sensory receptors



tactile

kinesthetic

proprioceptors

tactile::

sense of touch

the impression of **touch** is formed from several sensations including pressure, skin stretch, vibration and temperature

proprioception ::

sense of the relative position of neighboring body parts

provides feedback solely on the status of the body **internally**

it is the sense that indicates whether the body is **moving** with the required effort, as well as where the various parts of the body are **located in relation to each other**

kinesthesia ::

same thing

(though some place extra emphasis on **motion**
some excluding the sense of **equilibrium**)

1

"Cold"

TACTILE



1

"Cold"

2

"Hard"

KINESTHETIC
TACTILE



1

"Cold"

2

"Hard"



3

KINESTHETIC
"Slippery" TACTILE

haptic perception ::

the process of recognizing objects through touch.

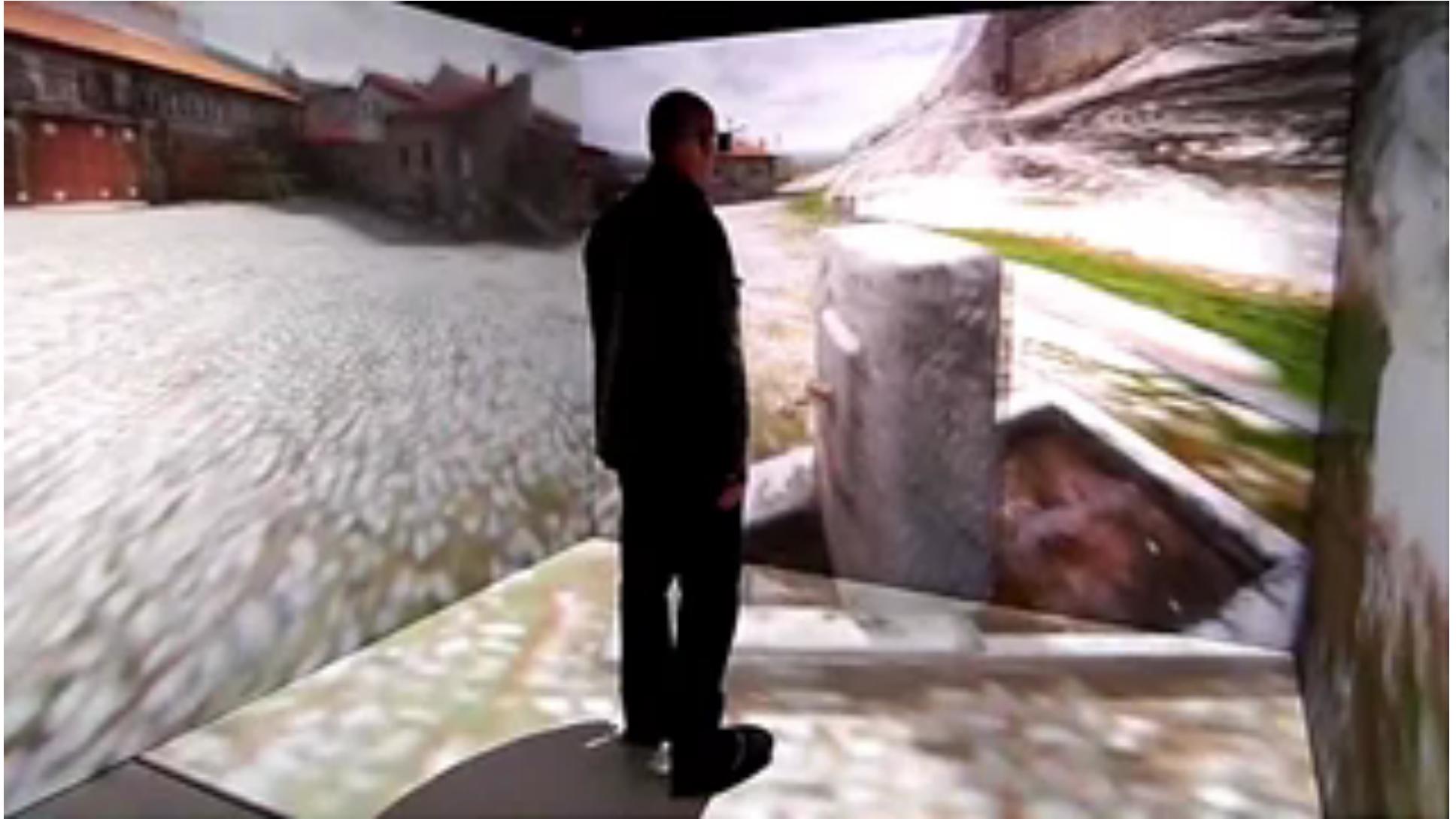
involves a **combination** of somatosensory perception of patterns on the skin surface (e.g., edges, curvature, and texture) and proprioception of hand position and conformation

haptics **combines**
multiple receptors (tactile and kinesthetic)
output and input (movement often required)

if we want the create realism,
we eventually need to **cater to all these (sub)senses**



1. force feedback

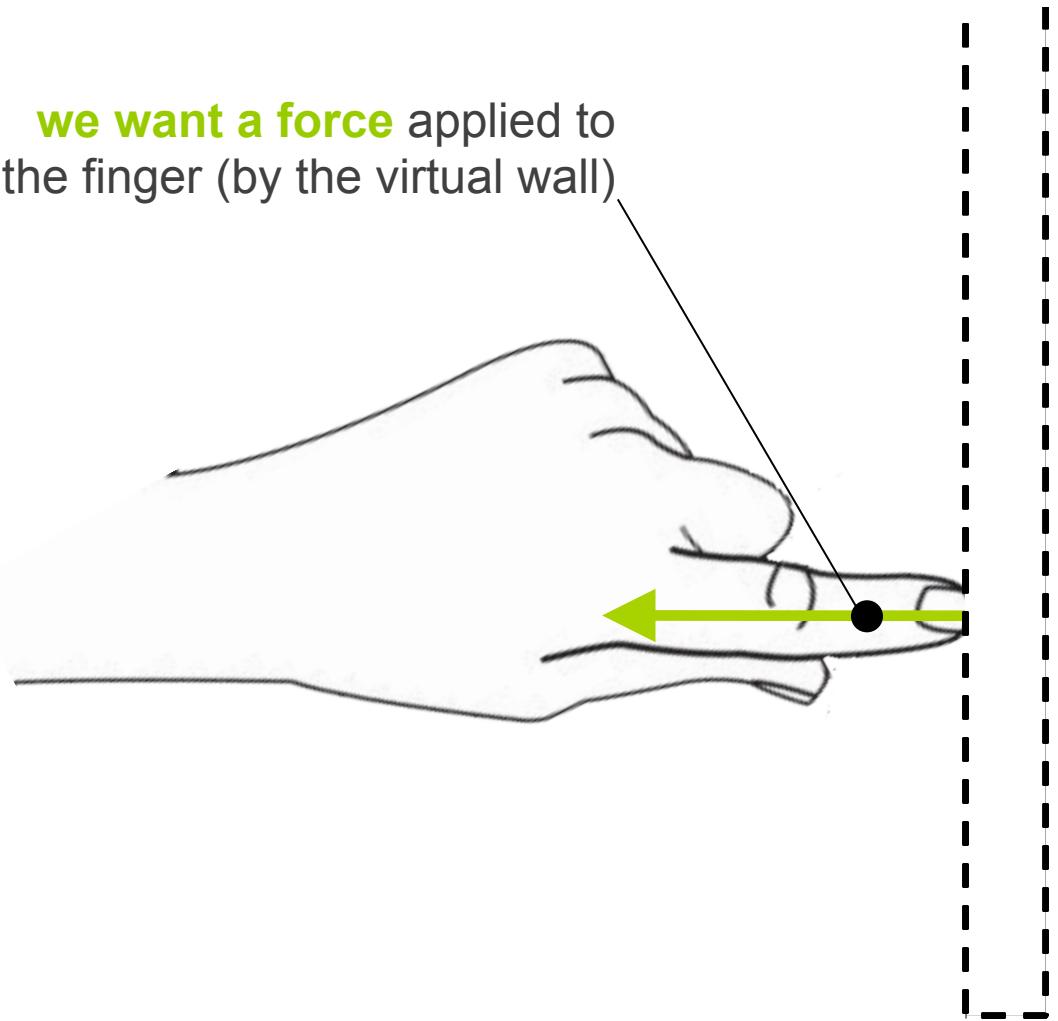


how to give users **push-back** when touching
an object



Level-ups Hasso plattner institut

we want a force applied to
the finger (by the virtual wall)





a common commercial solution...

[PHANToM, senseable]





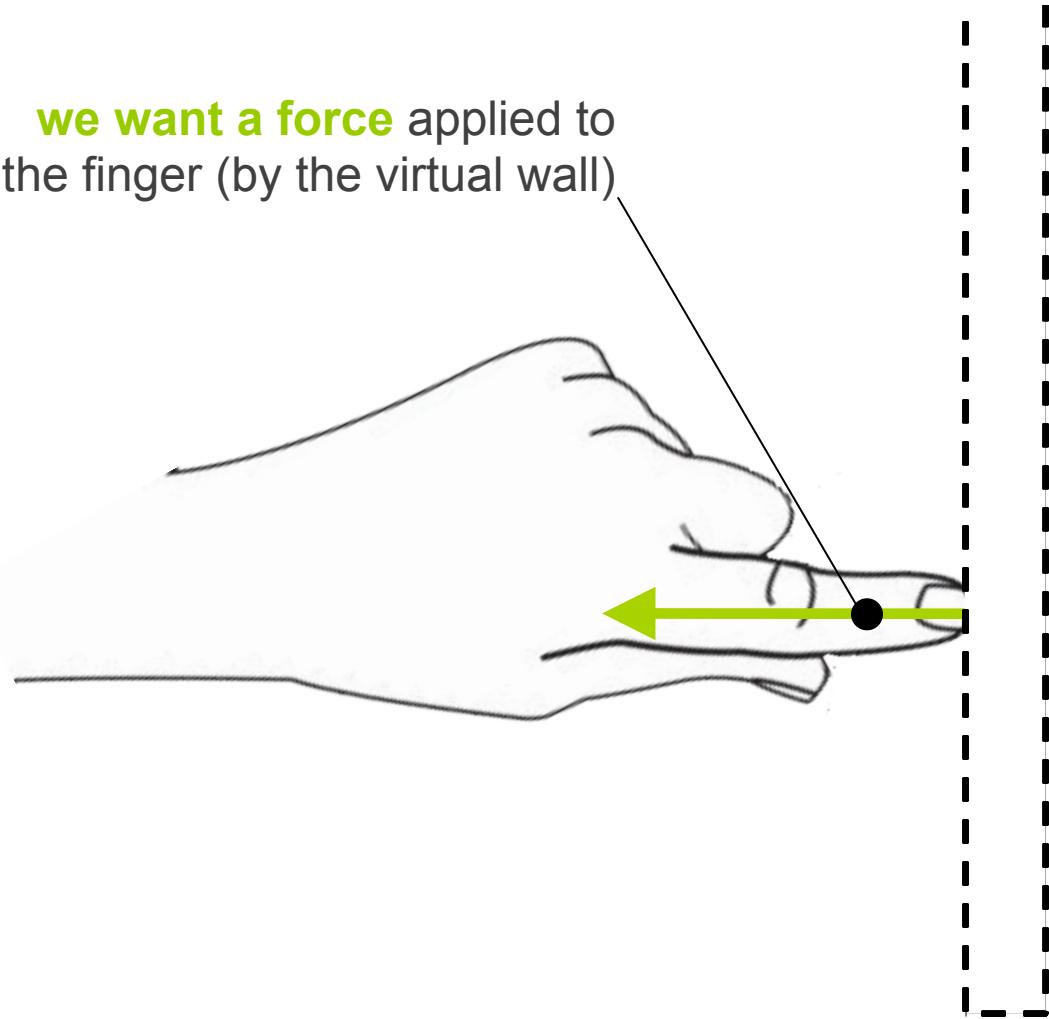
we have a phantom—**come try it out!**



other vendor, same thing

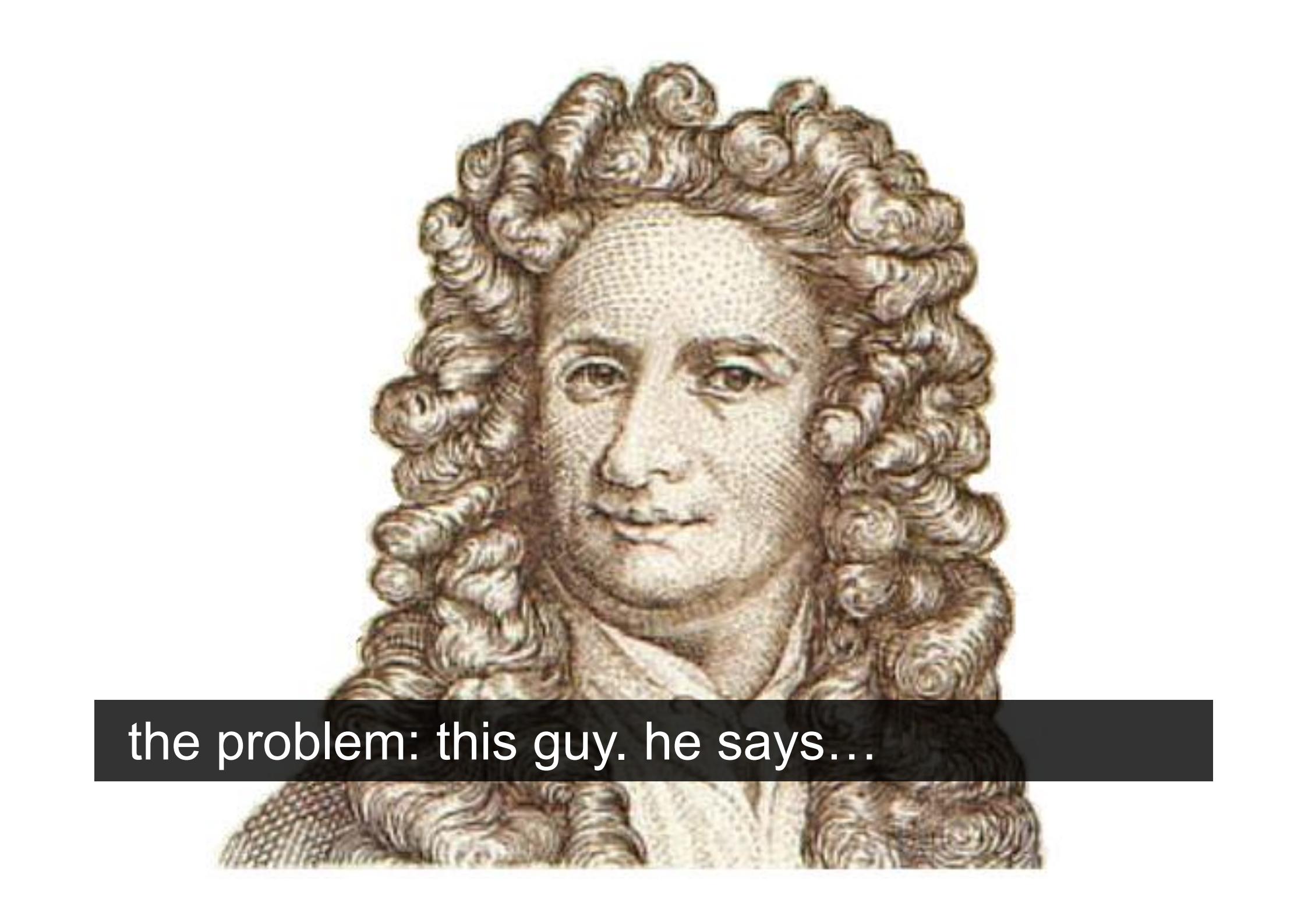
[Falcon]

we want a **force** applied to
the finger (by the virtual wall)



can we make this **mobile**?

<30sec brainstorming>



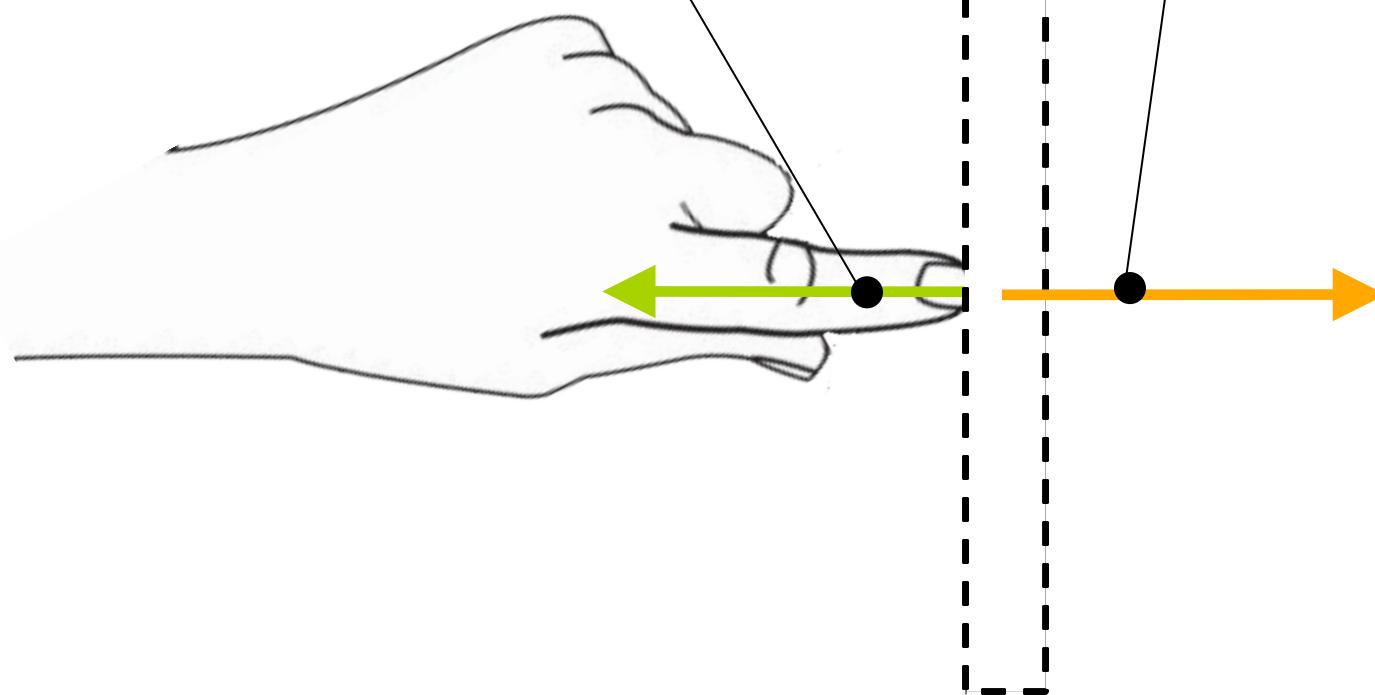
the problem: this guy. he says...

Newton's laws #3

for every action there is an equal and
opposite reaction

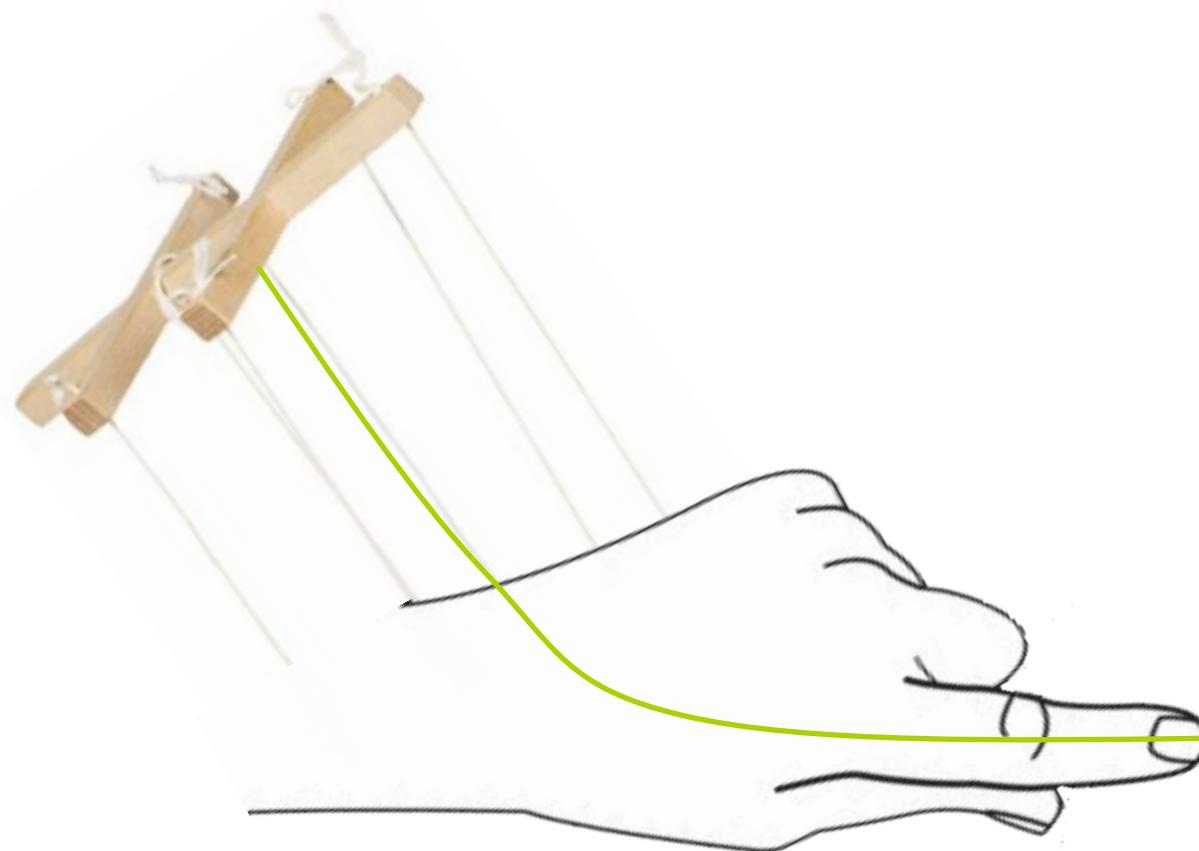


we want a force applied to
the finger (by the virtual wall)

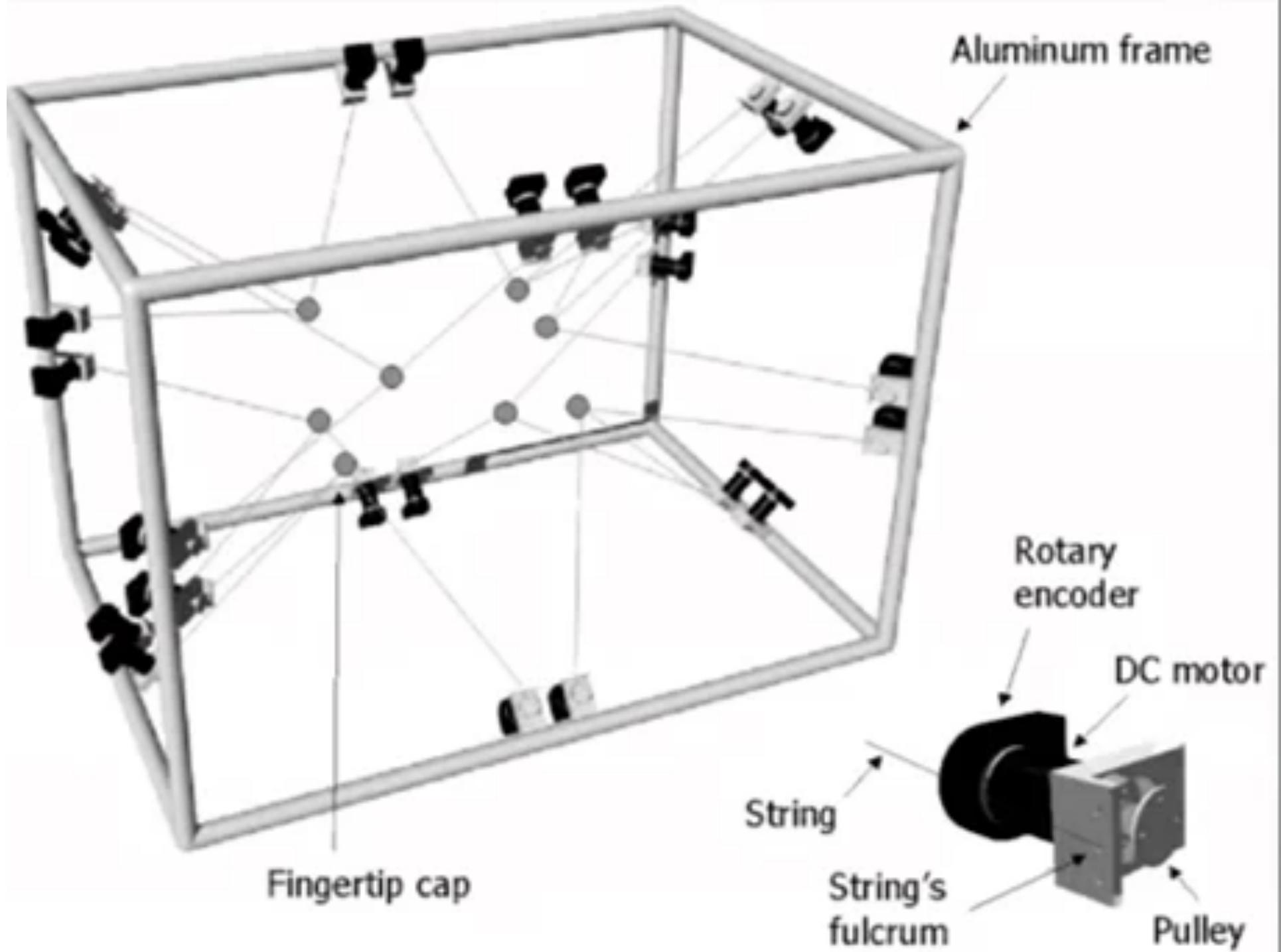


we need something to
absorb the opposite force
(on the wall by the finger)

the problem:



we can pull the finger back, but we need
some anchor to **attach the wires to...**

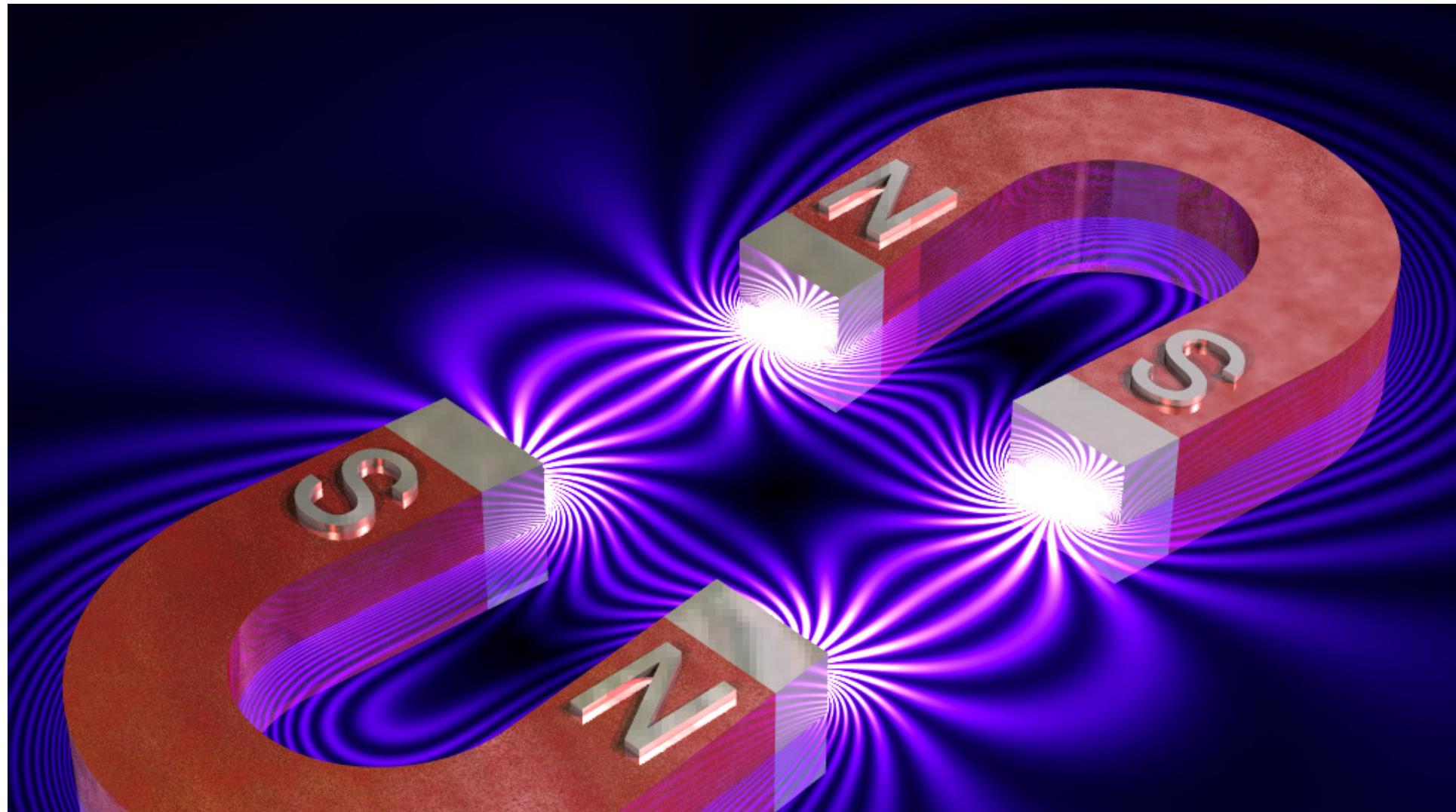




virtual canoe

[Hasegawa siggraph05]

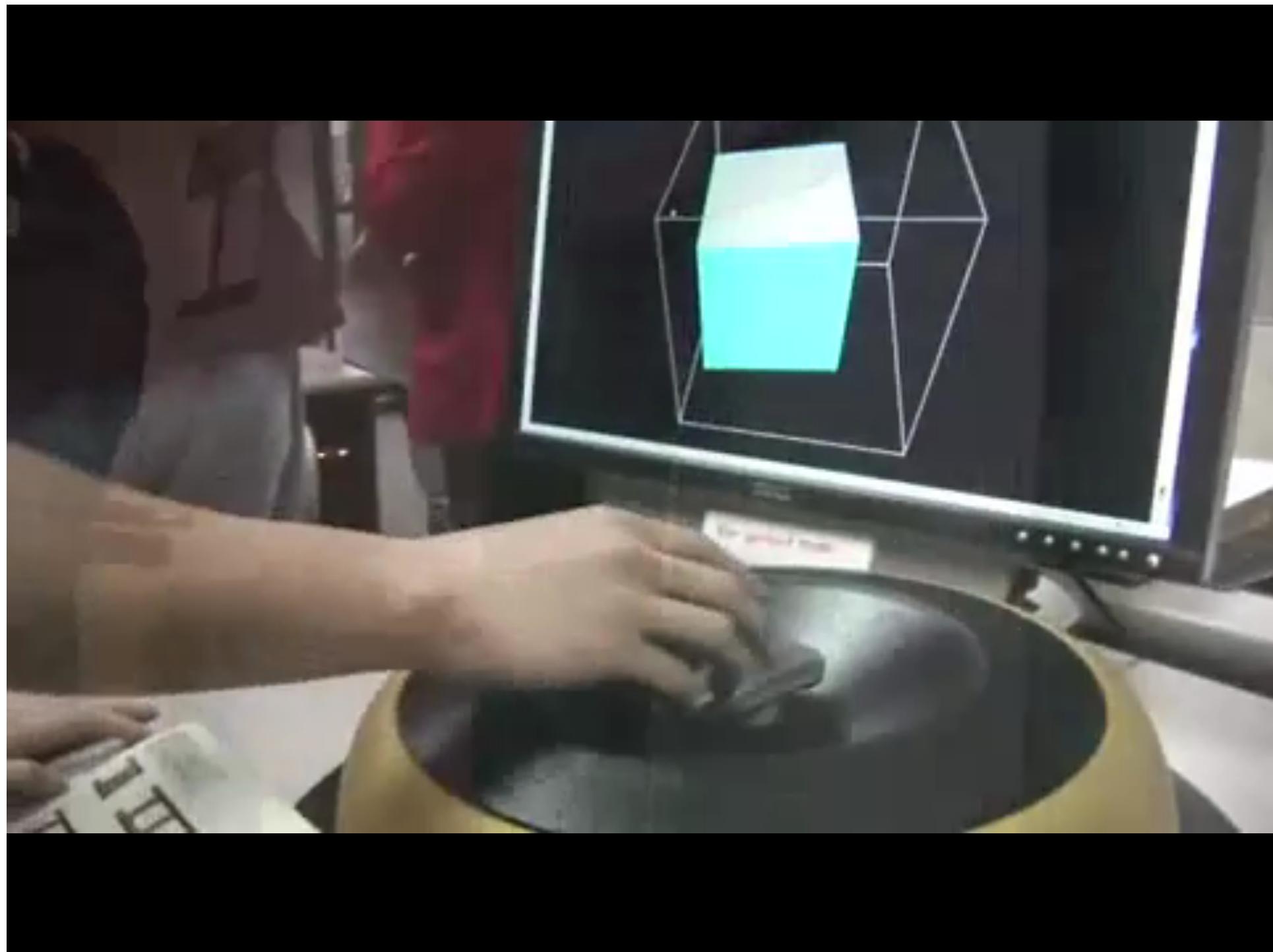
instead of **visible** strings, we can use invisible ones...



magnetic



maglev [Hollis]





acoustic radiation pressure. unlike air jets,
pressure from interference of the ultrasound.



[Iwamoto siggraph'08]

even if the “strings are invisible” all of these build up force
against some sort of **base station** (so not really mobile etc)

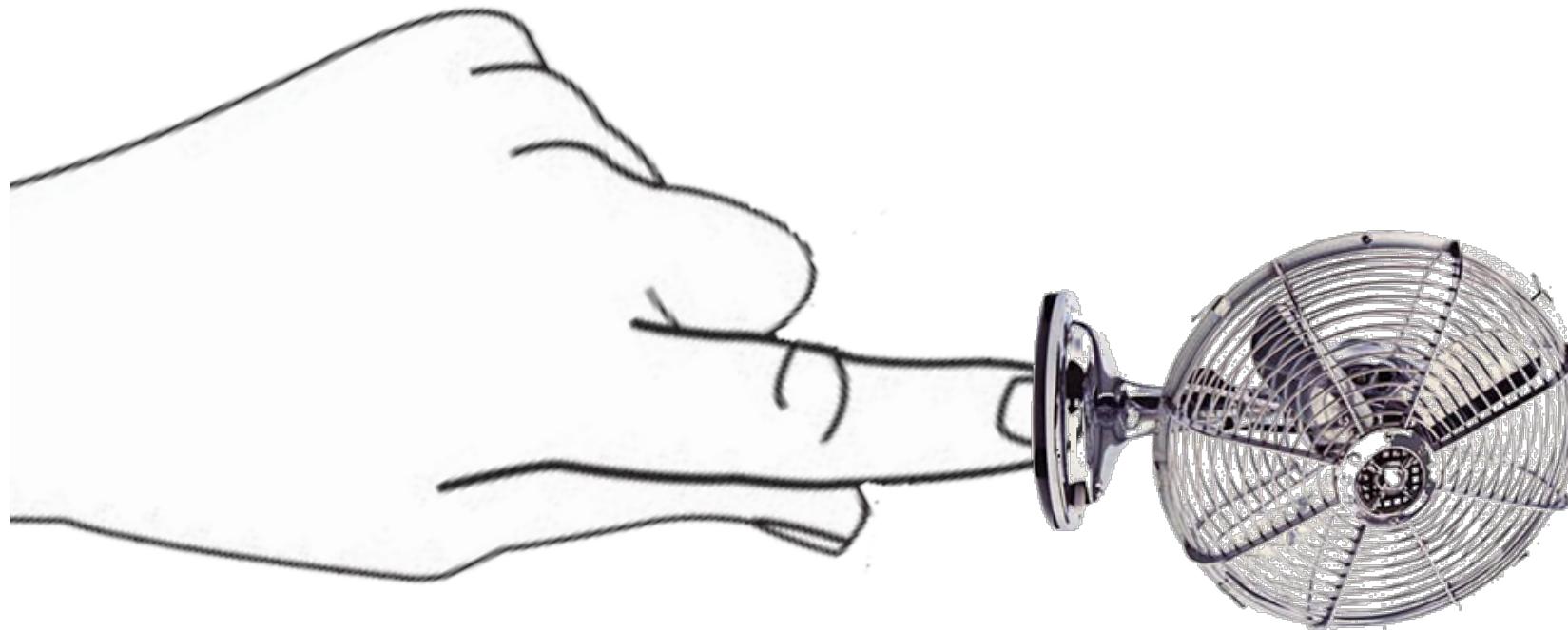
to achieve the same with
no-strings-attached would be...



rocket science...



(we should **try this** some time...)



but wait, we are inside the atmosphere
maybe **a fan** would be sufficient (**try this!**)

if we cannot truly produce a force, all we can do is...



2. vibration

how to cause vibration?

<30sec brainstorming>

mobile phones do it...

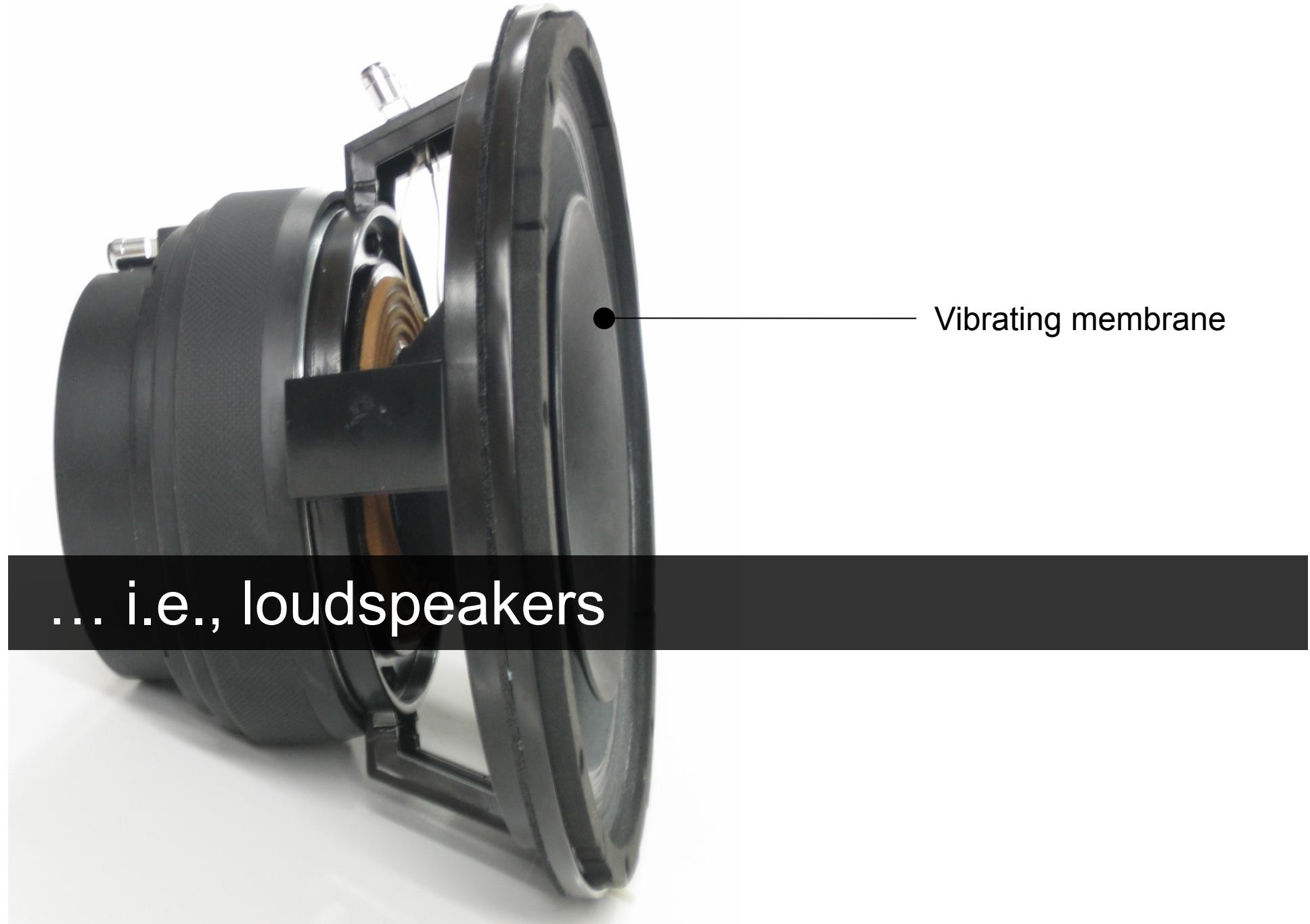




...using a motor spinning an **eccentric mass**



sound is vibration too → we can use sound equipment to generate vibration...





Press Esc to exit full screen mode.



piezoelectric effect : pressure \leftrightarrow electricity
piezo (πιέζειν) means squeeze or press

can vibro tactile replace force feedback?

<30sec brainstorming>



"Slippery"

3. friction

what can you do to a surface to increase its friction (make it
sticky) or reduce it (make it slippery)

<30sec brainstorming>



coat with liquid lubricant

coat with low-friction materials
(e.g. teflon)



friction: gas < liquid < solid < rough solid



coat with air



polish



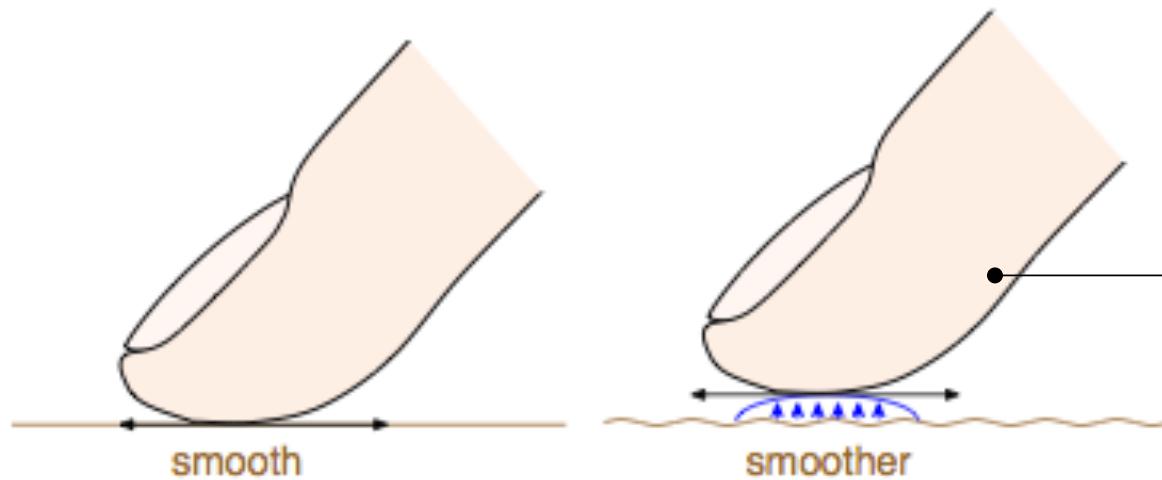
water cushion

that's why we slide on ice!



invent a machine that can change its surface properties
from **sticky or slippery**

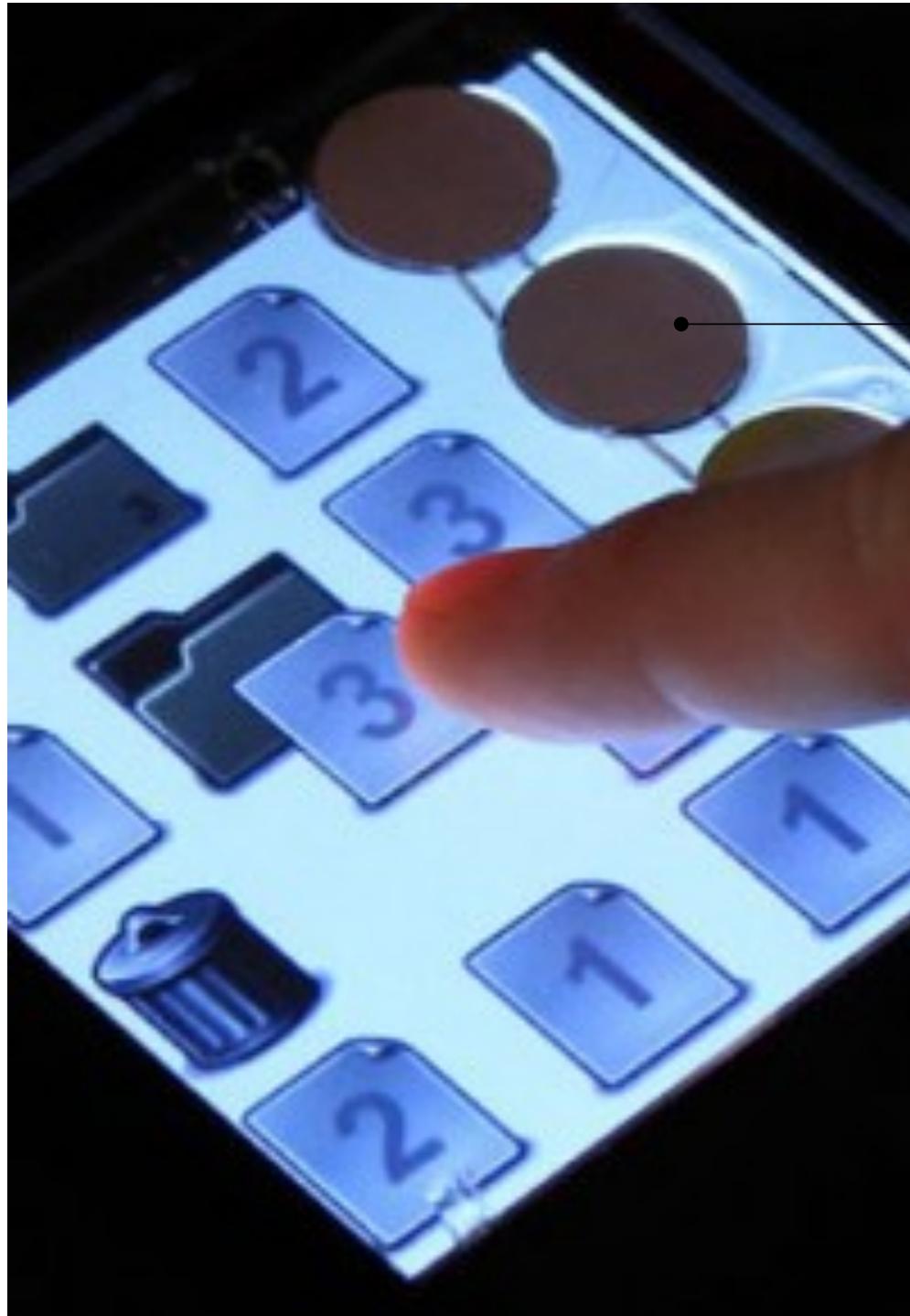
<30sec brainstorming>



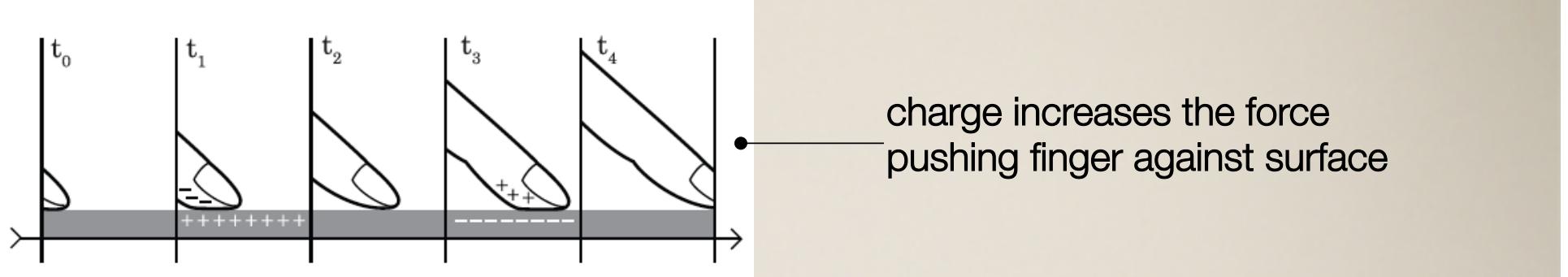
Ultrasonic vibrations
produce air that
changes friction
coefficient

stim tac vibrates the surface,
this producing an air cushion (squeeze film)

[Biet 07, Watanabe ICRA'95, Winfield World Haptic 07]



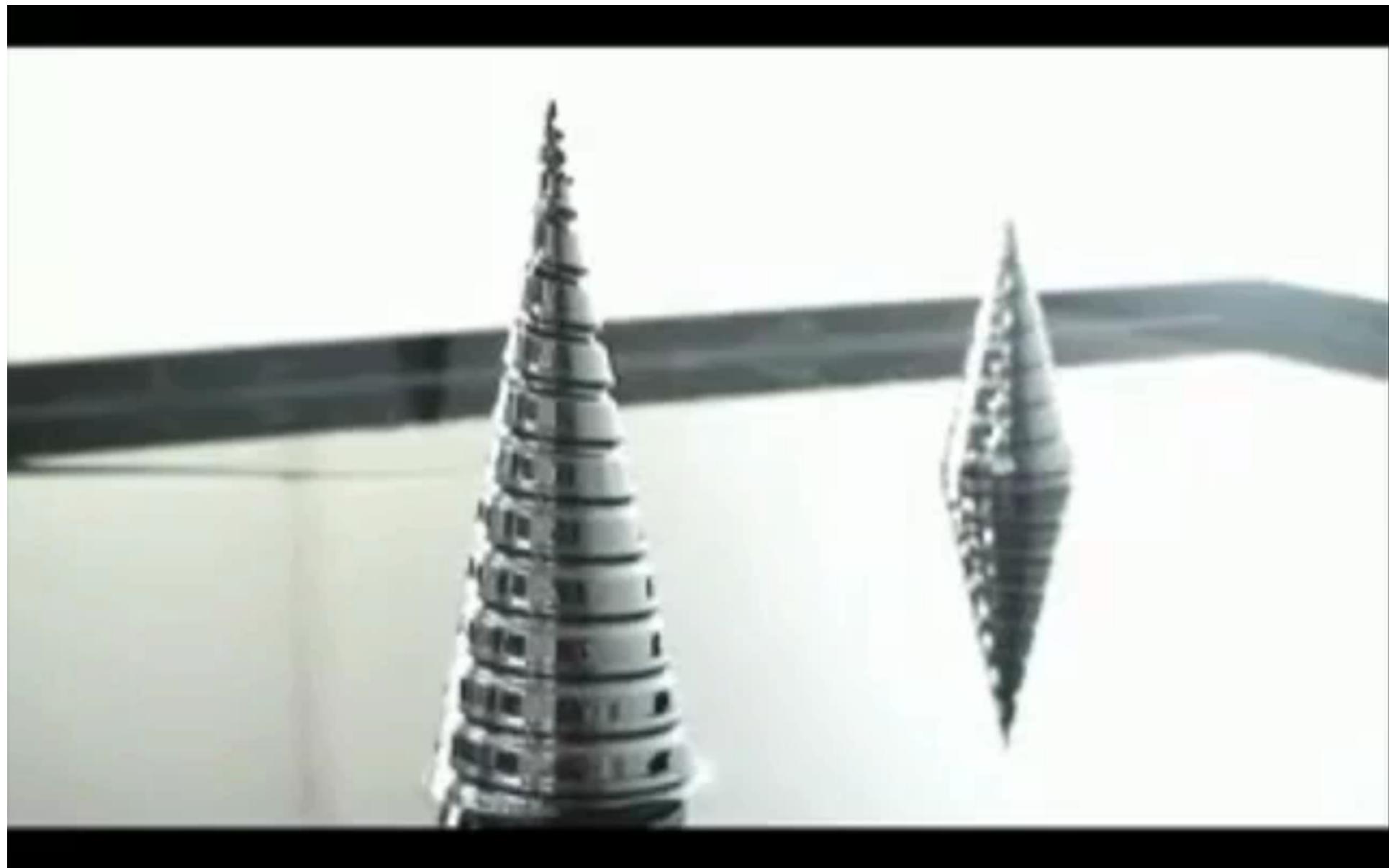
[Levesque chi11
Casiez chi 11]

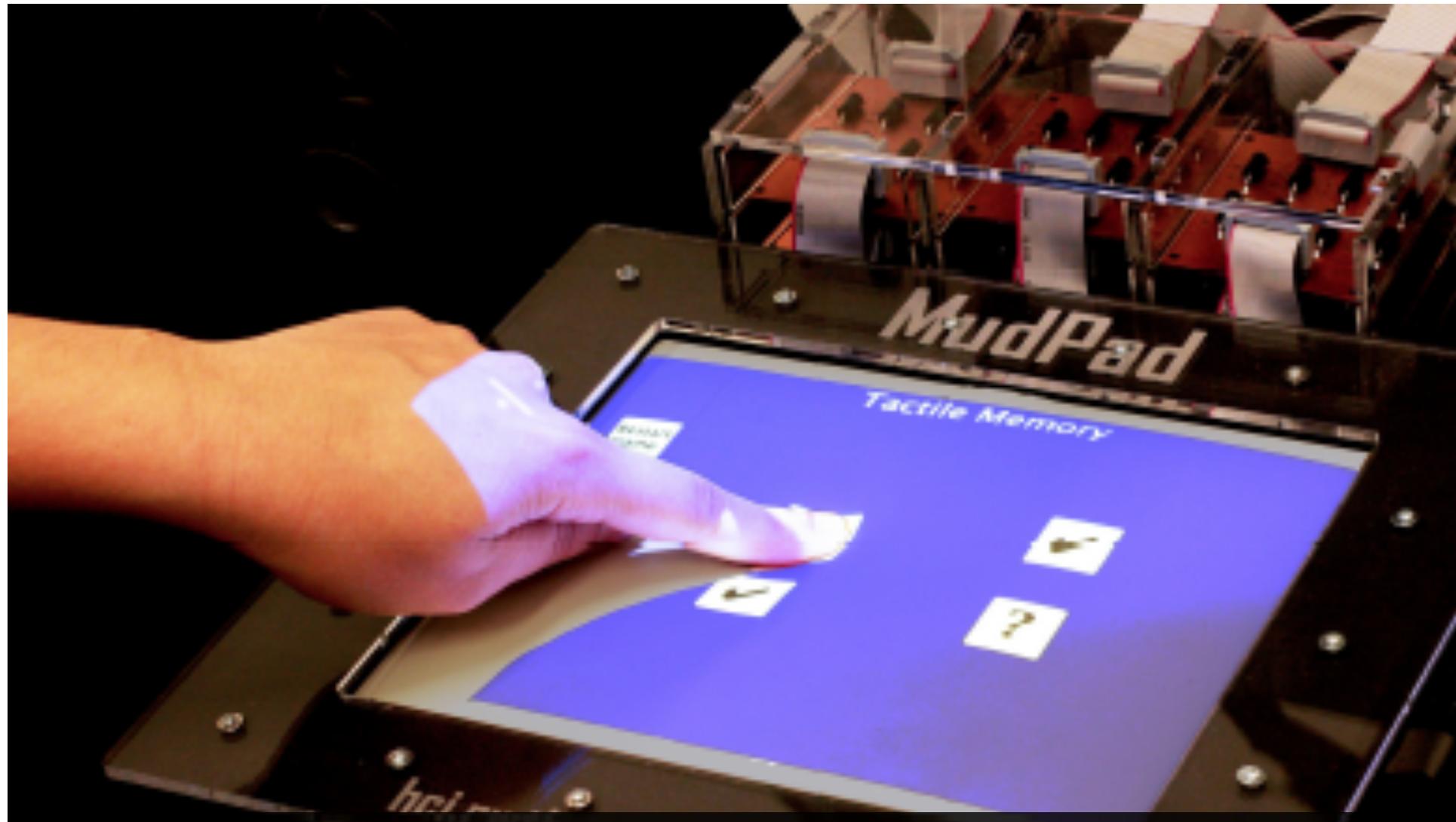


here a different approach to change **the viscosity** ...

ferrofluid ::

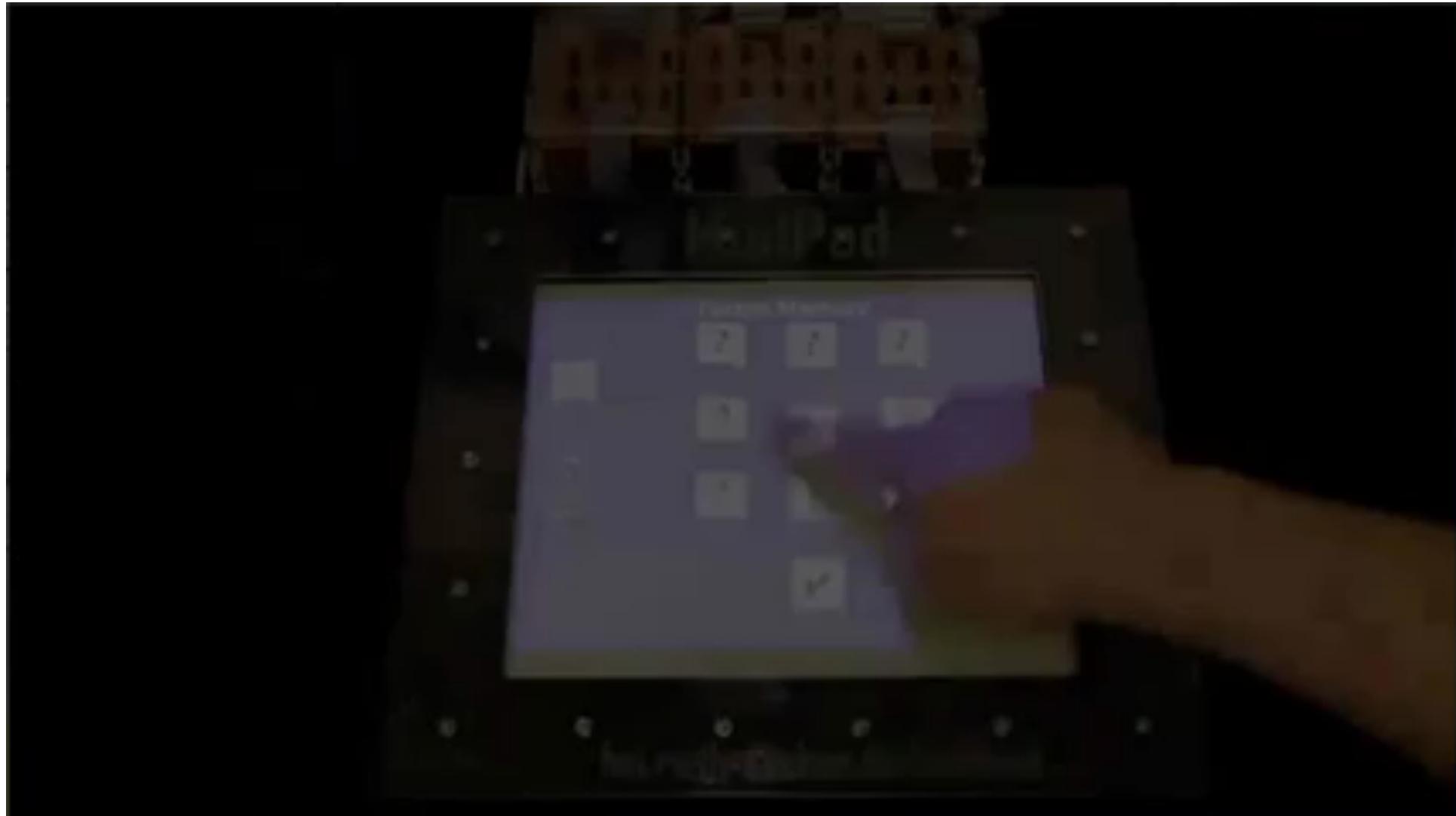
A ferrofluid (compound of Latin ferrum, meaning iron, and fluid) is a liquid which becomes strongly magnetized in the presence of a magnetic field.





make surface hard and soft

mudpad [Jansen ITS10]

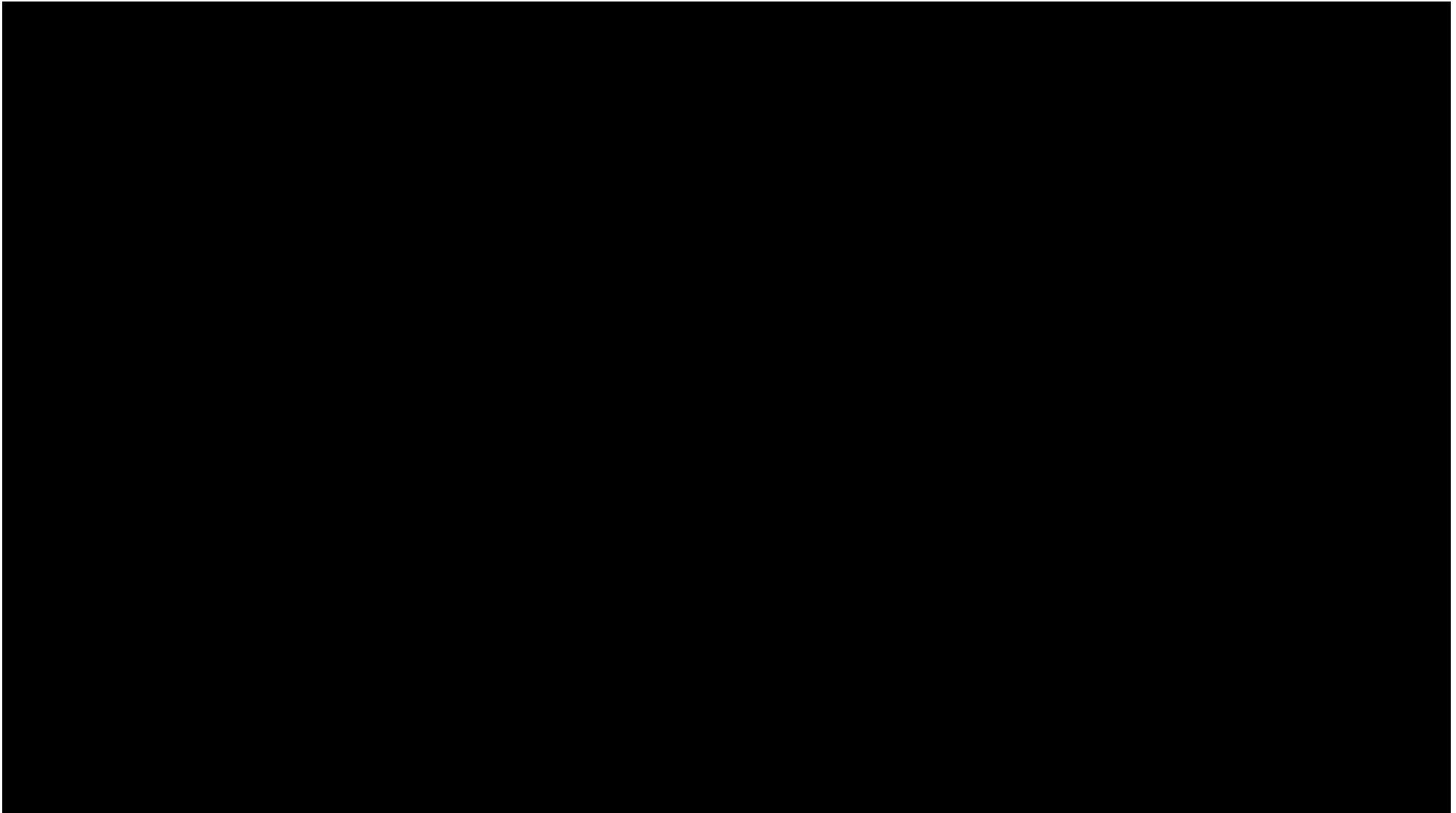


mudpad [Jansen ITS10]

another approach to changing **the hardness...**



vacuum mattress to transport spinal injuries



[Matoba Siggraph12]



we can use haptic to increase **realism / immersion**

what else?

many other applications not presented:

Sensory substitution systems (e.g. displays for the blinds)

Entertainment industry (e.g. computer paddles)

Medical world (e.g. virtual surgery training, remote surgery)

Learning (e.g. Learning cursive writing)

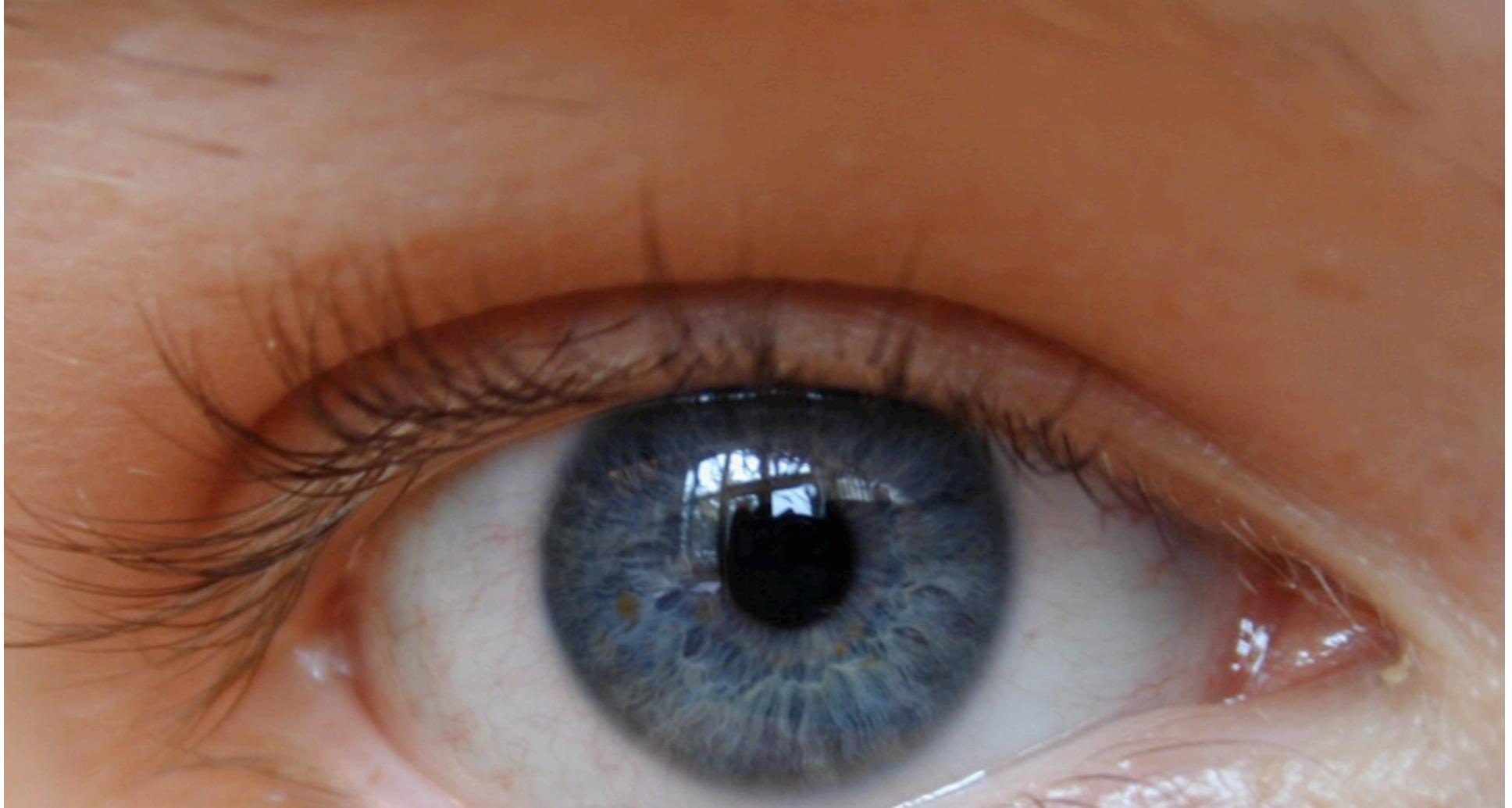
Military (e.g. Battlefield conditions)

E-commerce (e.g. remote sensing of a material via the web)

Museum (e.g. “touching” sculptures)

Research world (e.g. study of mechanoreceptors)

convey
information



visual sense has the highest bandwidth of the five senses → default for conveying information but the **visual senses may be unavailable**



in **low-vision** situations...



eyes-free use while focusing on something else



and visually disabled users of course

we can convey:
events, locations, one- and multi-dimensional **parameters...**



icons



serialize

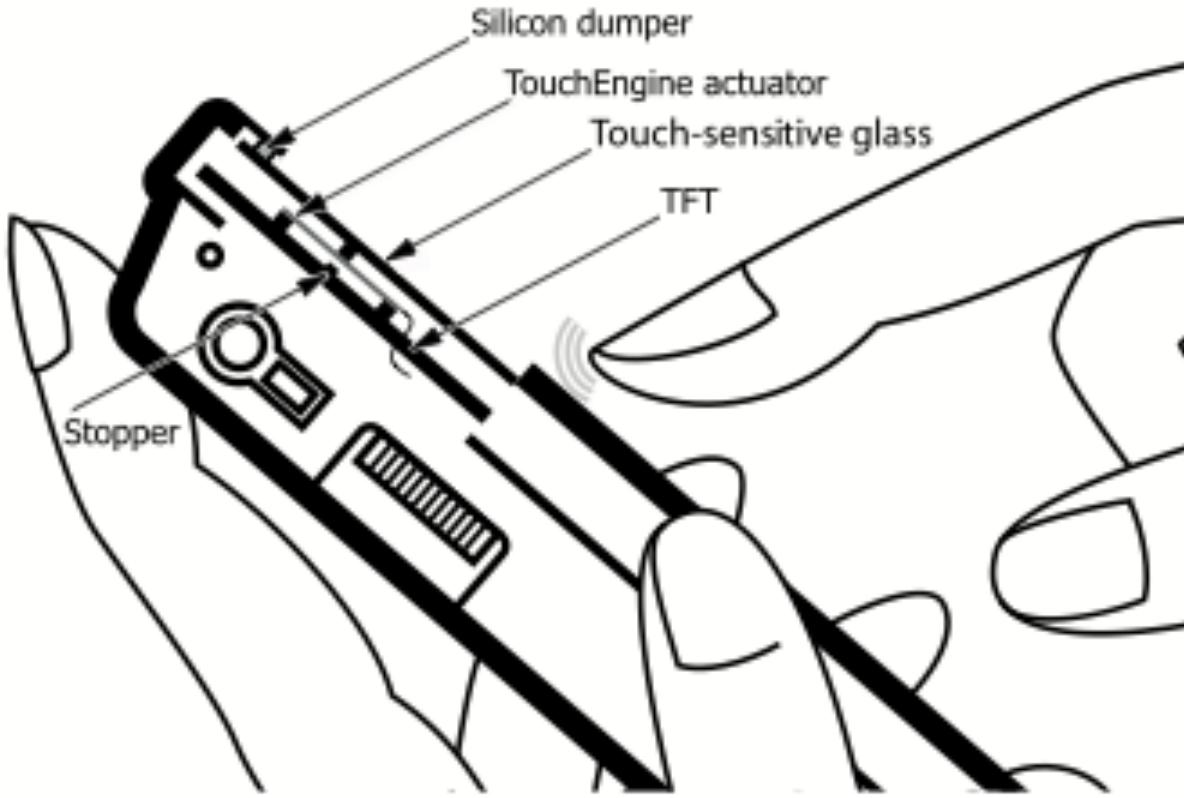
earcons



apply to
skin

tactons

show an event by frequency, amplitude and duration of a tactile pulse, rhythm, location



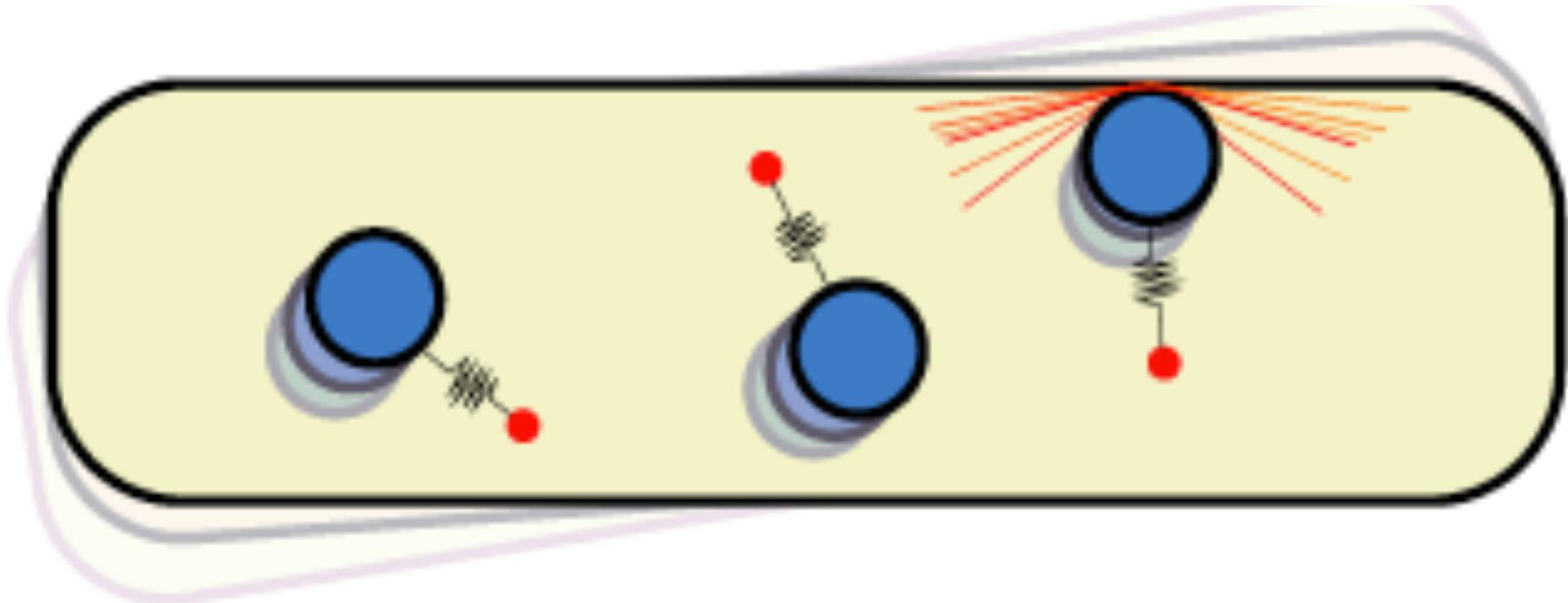
on single touch, ok to **vibrate entire device**

[Poupyrev UIST03, Brewster CHI07]



conveying **location** using many actuators

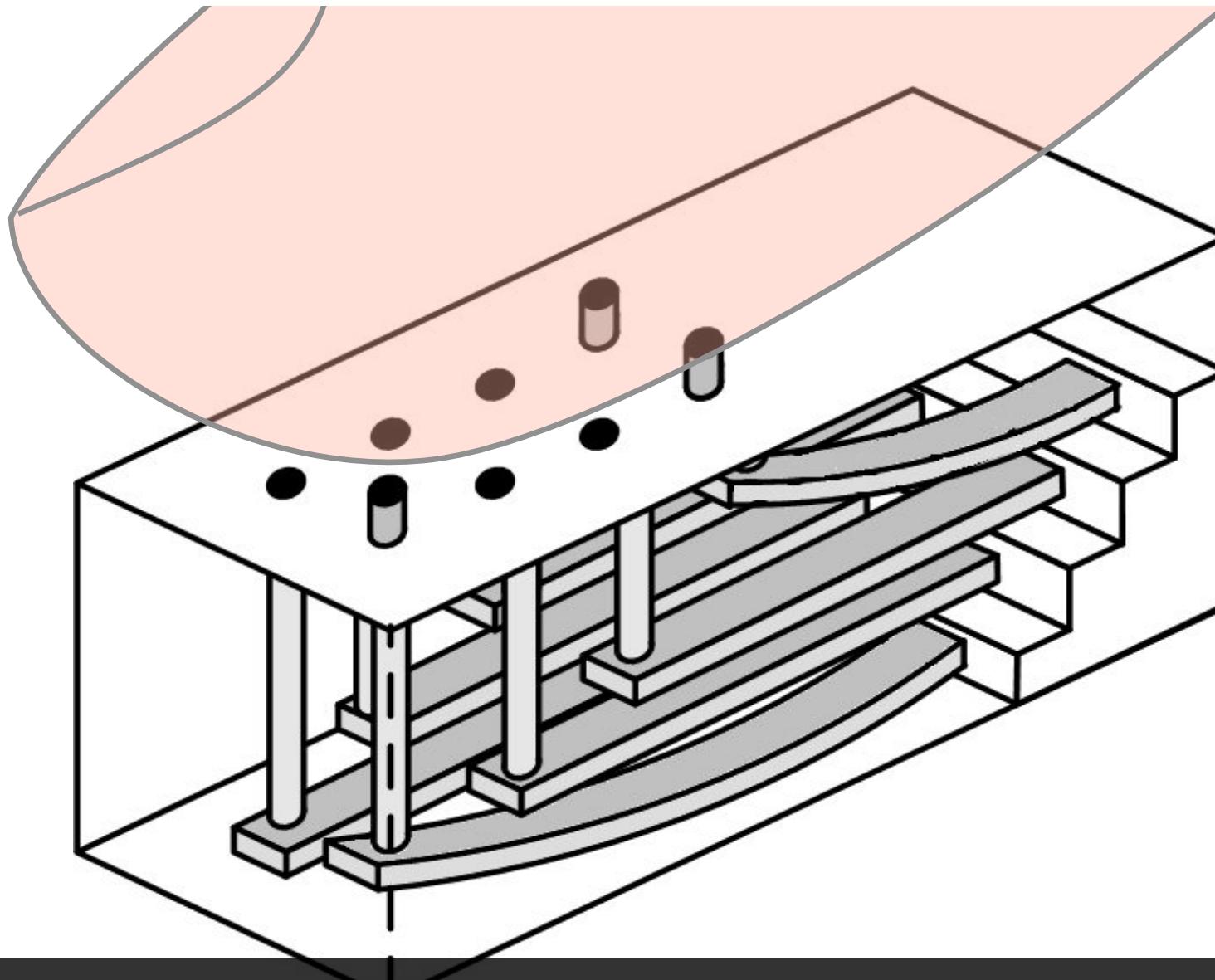
tactile brush [Israr CHI11]



convey a **natural number**, here # of emails

Shoogle [Williamson CHI07]

conveying **text & 2D information** using **braille...**



braille cells allow blind users to **read text**



are small so we can add them anywhere

Tongue display unit [Bach-y-Rita]

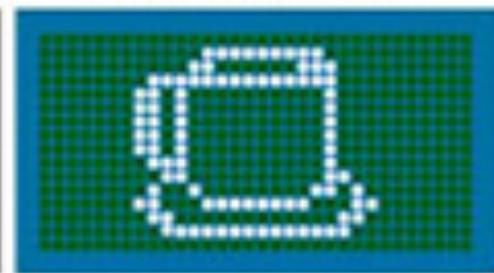


user's tongue **scans** the array

ACQUIRED IMAGE



TACTILE IMAGE

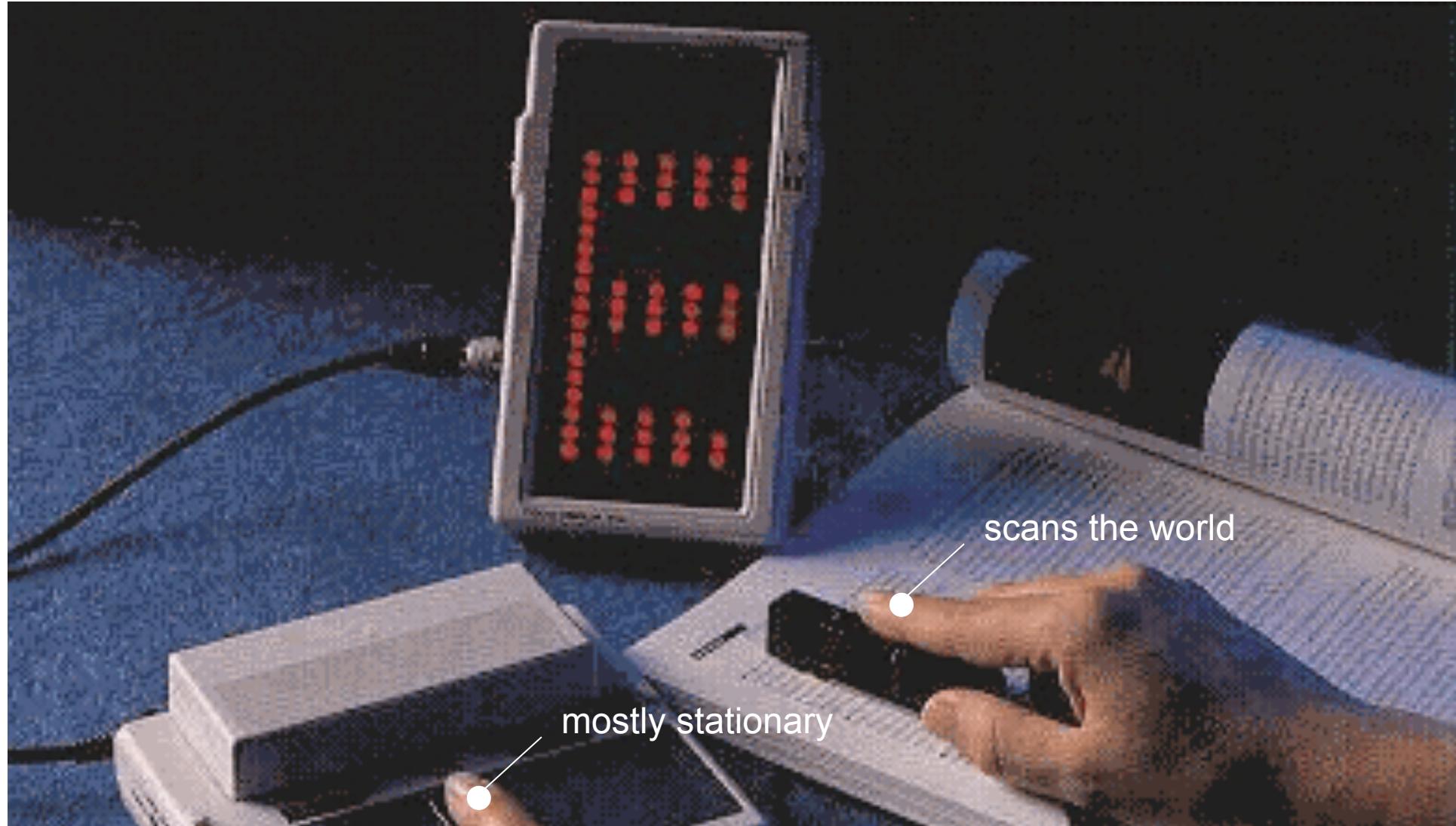


CAMERA



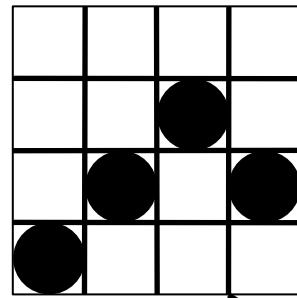
fully stationary Braille array

Forehead retina system [Kajimoto]

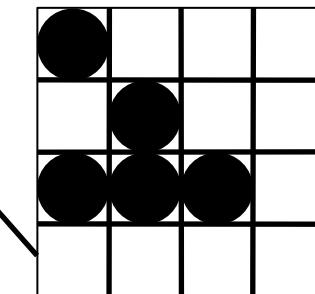
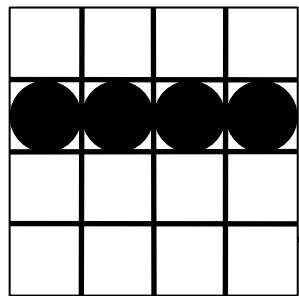


one hand scans the world → small array

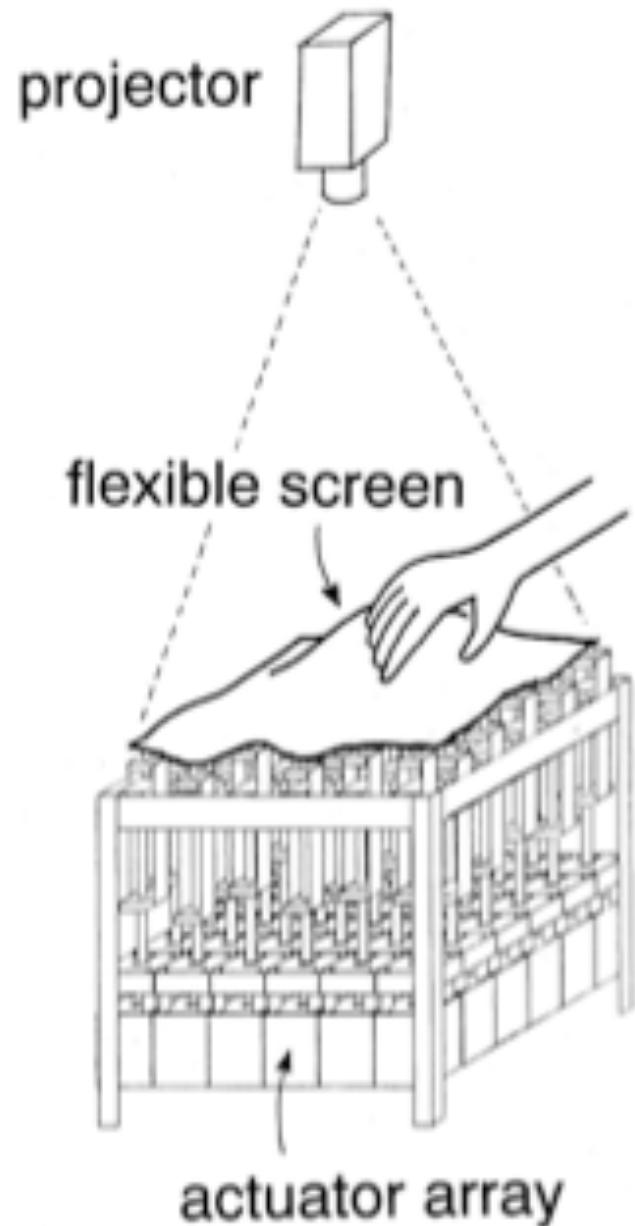
Optacon



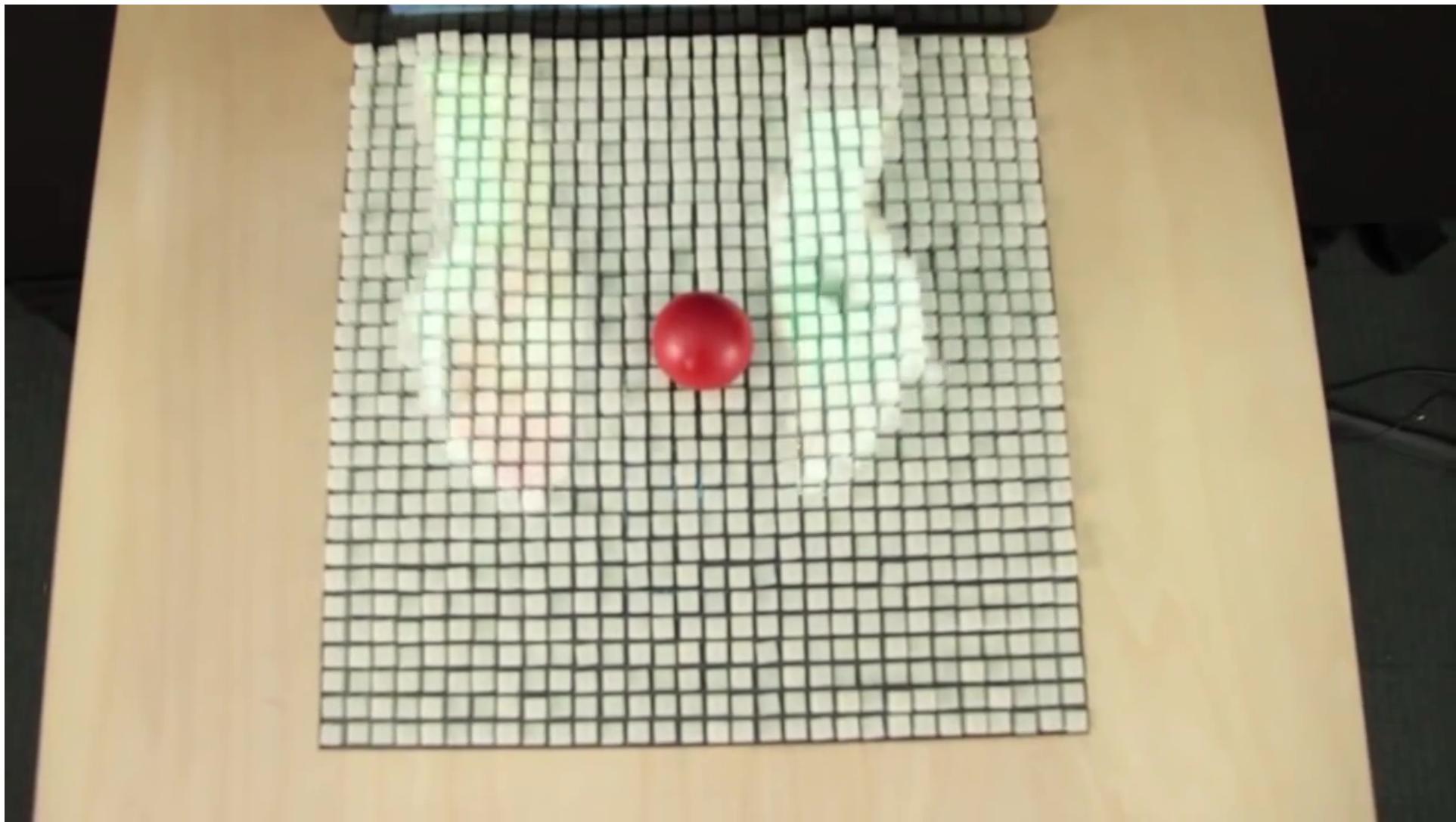
used to scan objects sequentially



we can also think larger ...



2½D shape displays convey shape not texture



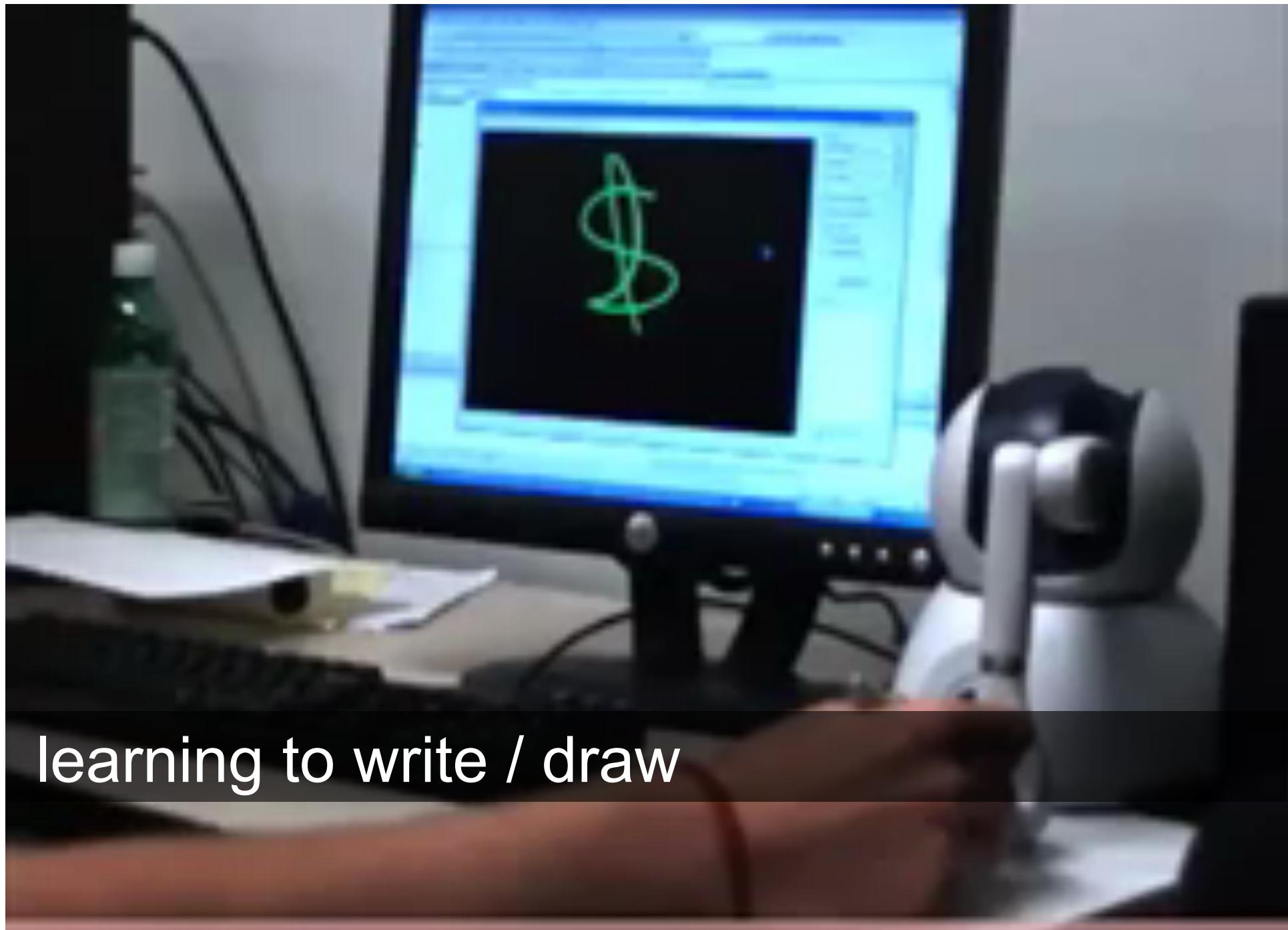
[Follmer UIST 2015]

training with
haptic

constraining the user to prevent dangerous or “illegal” interactions, e.g., in medical



feedback in remote surgery



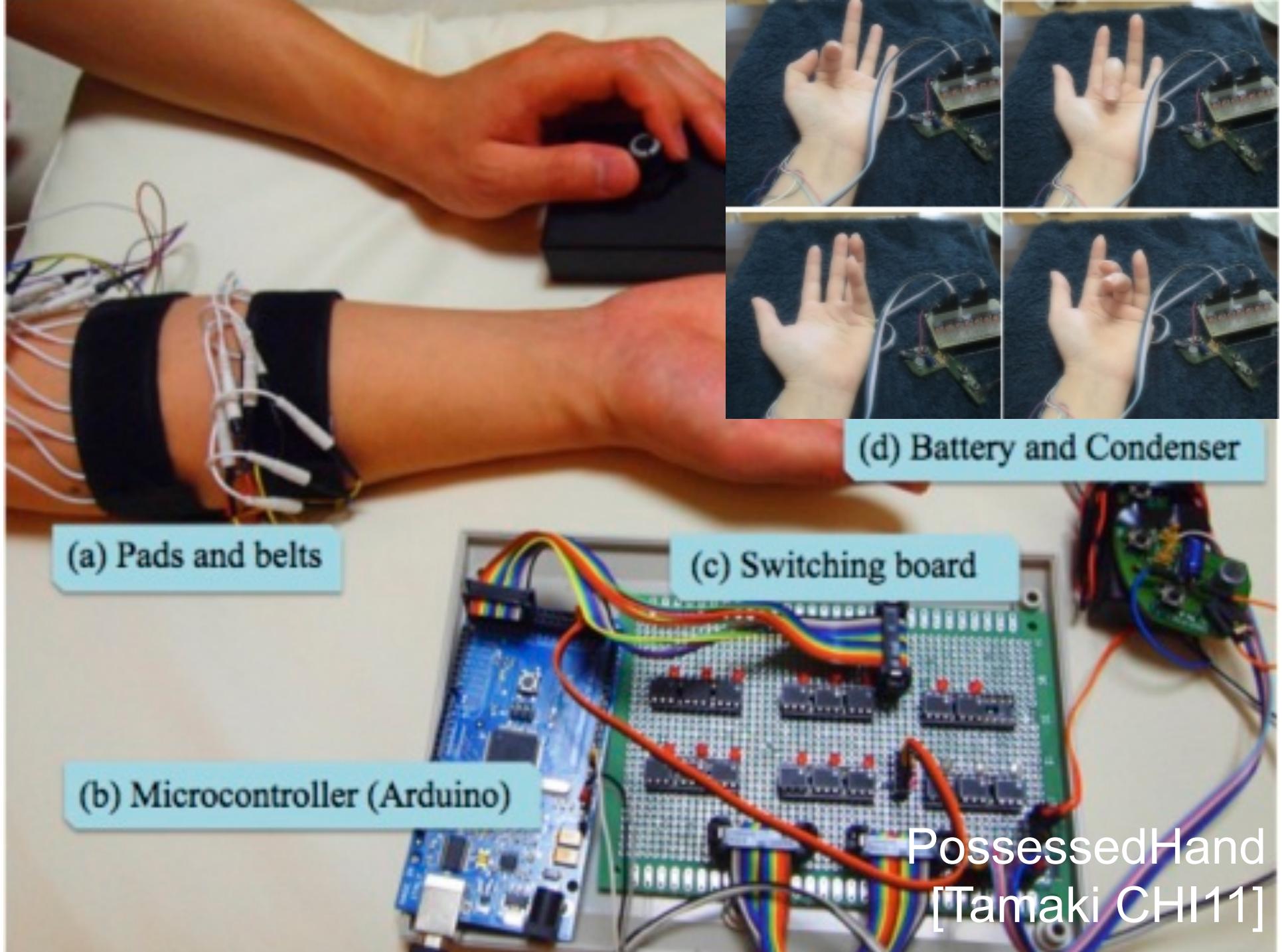
learning to write / draw

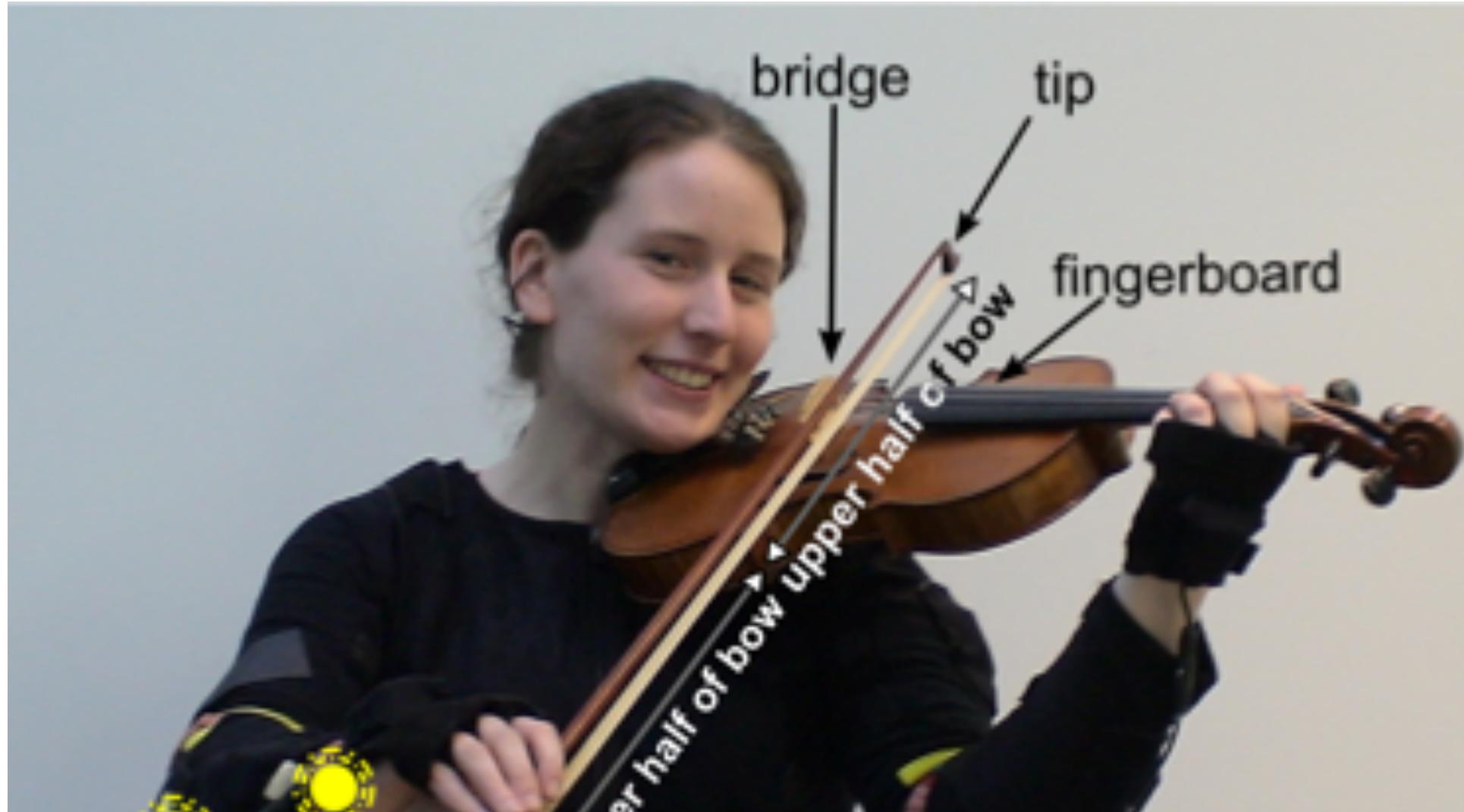
some techniques **actuate the body directly**



electro stimulation

control body movements by directly sending electric charges in the nerves





buzzes if violin too high or low
(only vibration, not as good as force)

[Van Der Linden CHI11]



“possessed hand”

[Tamaki CHI11]

and all the other things we saw in the **Interactive
Fabrication lecture**



next week: presentation of results in class
(5 min presentation + 5 min feedback)

prepare ppt or pdf slides (5 slides max) with **graphs** illustrating your study results

send by email (csxar@bristol.ac.uk)
by Monday 30 9:00am



end