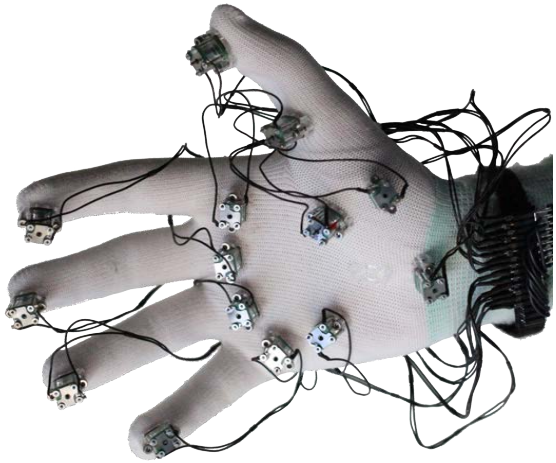
Soft Flexible Haptic Displays for AR/VR and Wearable Computing



(**EPFL**-LMTS)
Prof. Herbert Shea
Dr. Ronan Hinchet
Dr. Juan Zarate

(**ETHZ**-AIT)
Prof. Otmar Hilliges
Mr. Velko Vechev
Dr. Fabizio Pece

Our Team


Dr. Juan Zarate


Dr. Ronan Hinchet


Prof. Herbert Shea


Prof. Otmar Hilliges

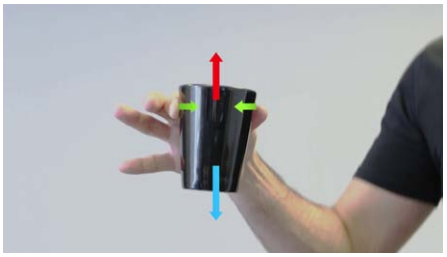

Mr. Velko Vechev


Dr. Fabizio Pece

EPFL Soft Transducers Lab
- Prof. Herbert Shea
- Dr. Ronan Hinchet
- Dr. Juan Zarate

ETHZ Advanced Interactive Technologies Lab
- Prof. Otmar Hilliges
- Mr. Velko Vechev
- Dr. Fabizio Pece

There is a need for a glove for VR/AR that allows truly feeling and manipulating virtual objects.



Dexterous Manipulation of Virtual Objects

Virtual Robotic Operation

Realistic Experiences

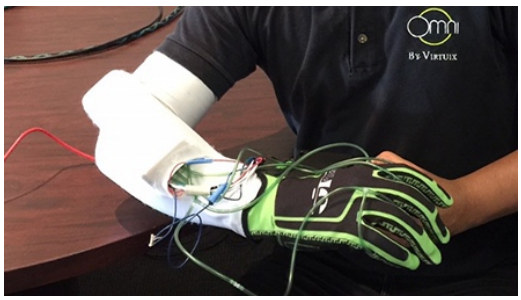
The primitive or bulky state of Wearable haptic feedback today…

[Teslasuit.com]

https://haptx.com/

[Manus VR]

[DextaRobotics – Dexmo

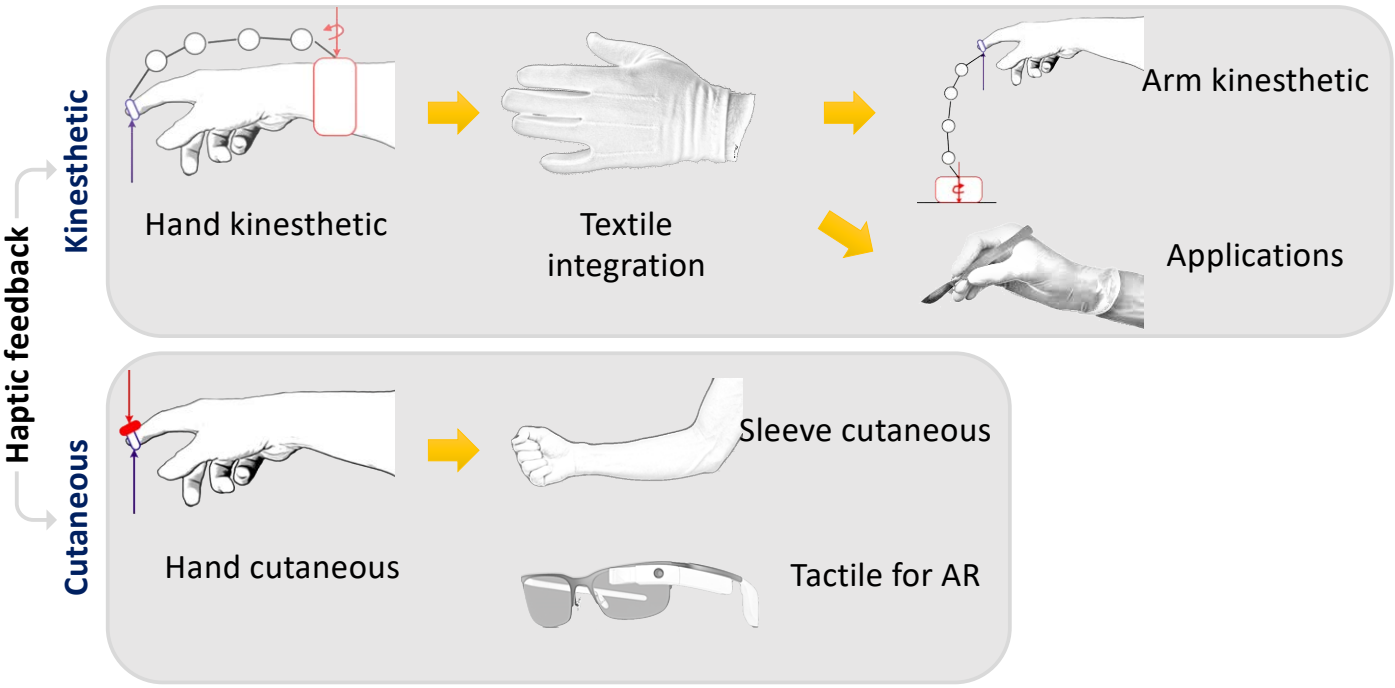


[Gloveone]

EPFL

For an effective haptic glove, we need to solve
two levels of actuation challenge

ETH zürich

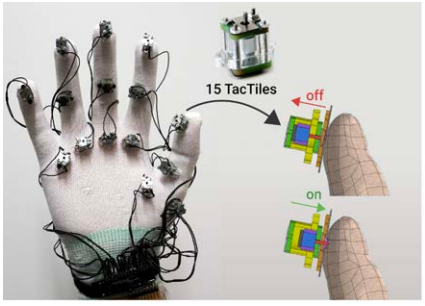


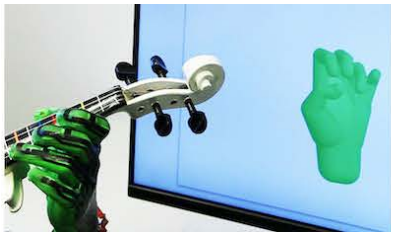
EPFL

ETH zürich

Our key accomplishments to date in this project

1. DextrES – kinesthetic glove
2. Tactiles – cutaneous glove
3. Pose sensing glove

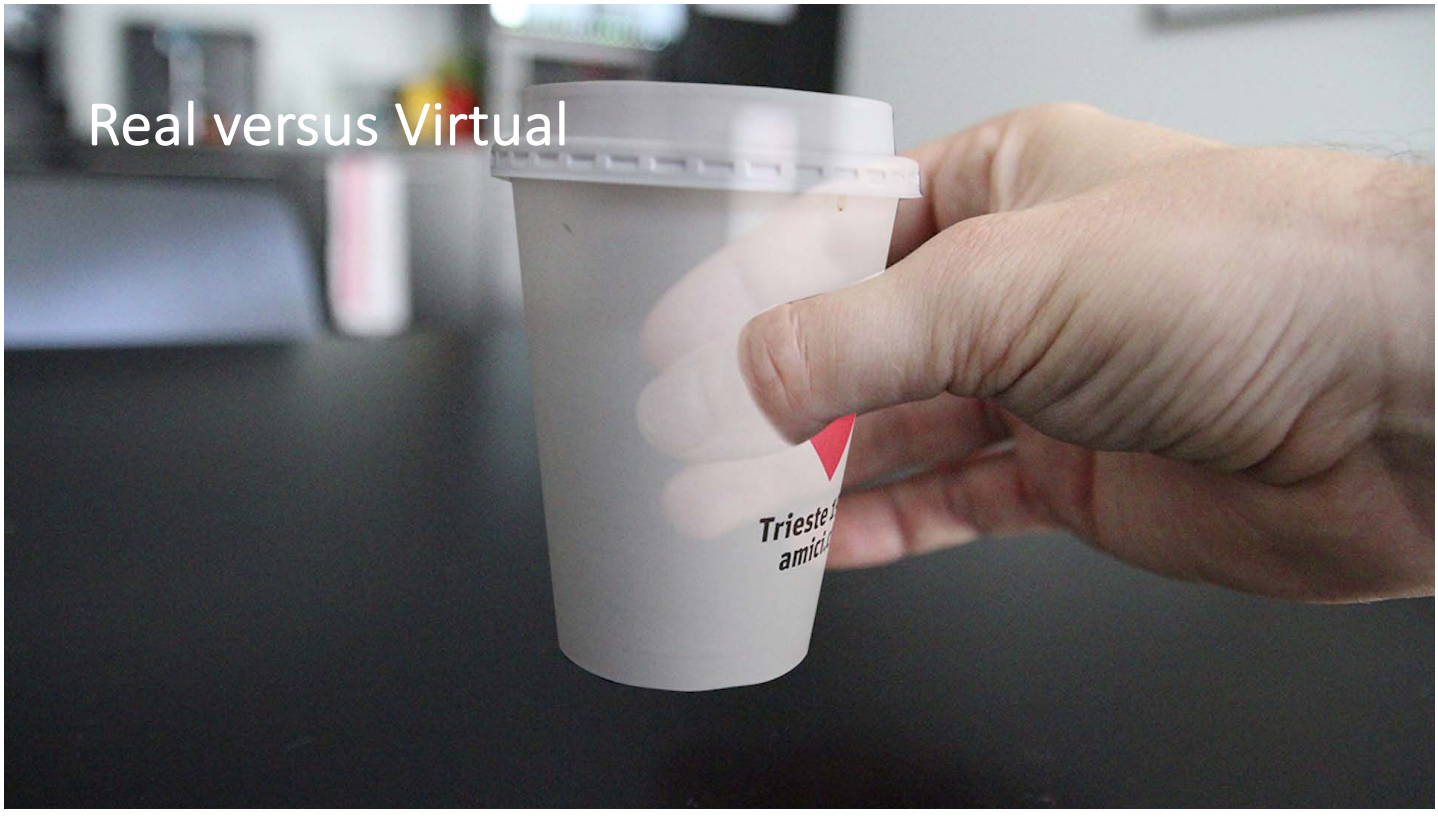




EPFL ETH zürich

1. DextrES: a low-power Wearable Electrostatic Clutch

dynamically blocks finger motion to give the impression of solidity to virtual objects



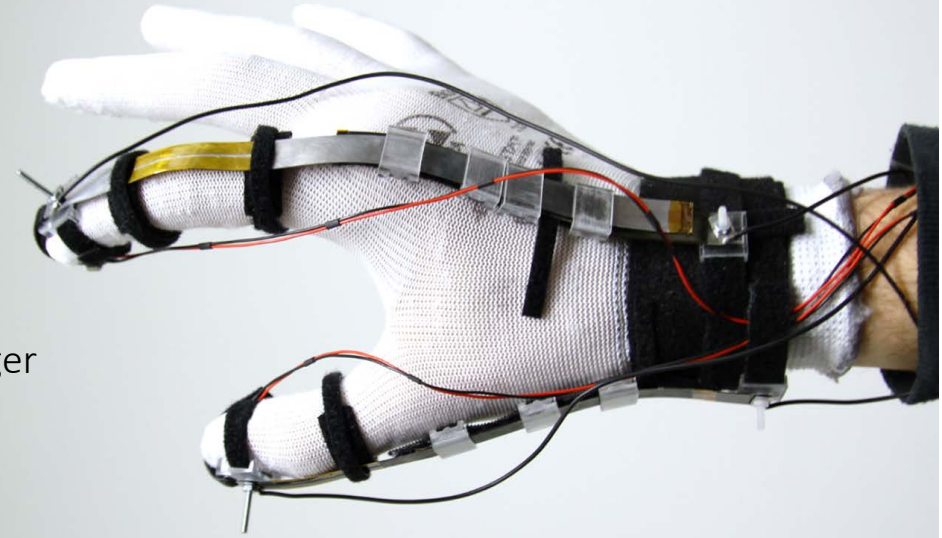
A light-weight glove that blocks finger motion (gen 1)

Kinesthetic Feedback

Flexible and thin

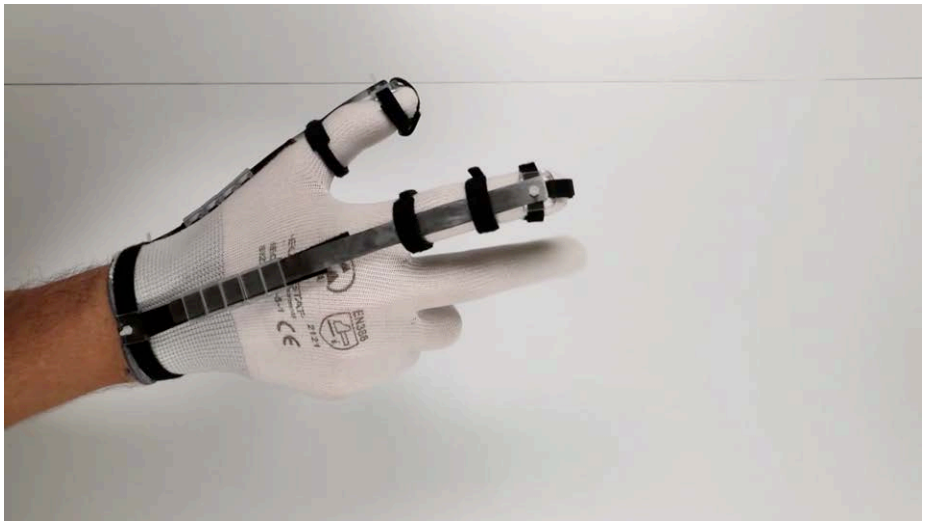
Lightweight (8 g per finger)

Low Power : 2 mW per finger



EPFL

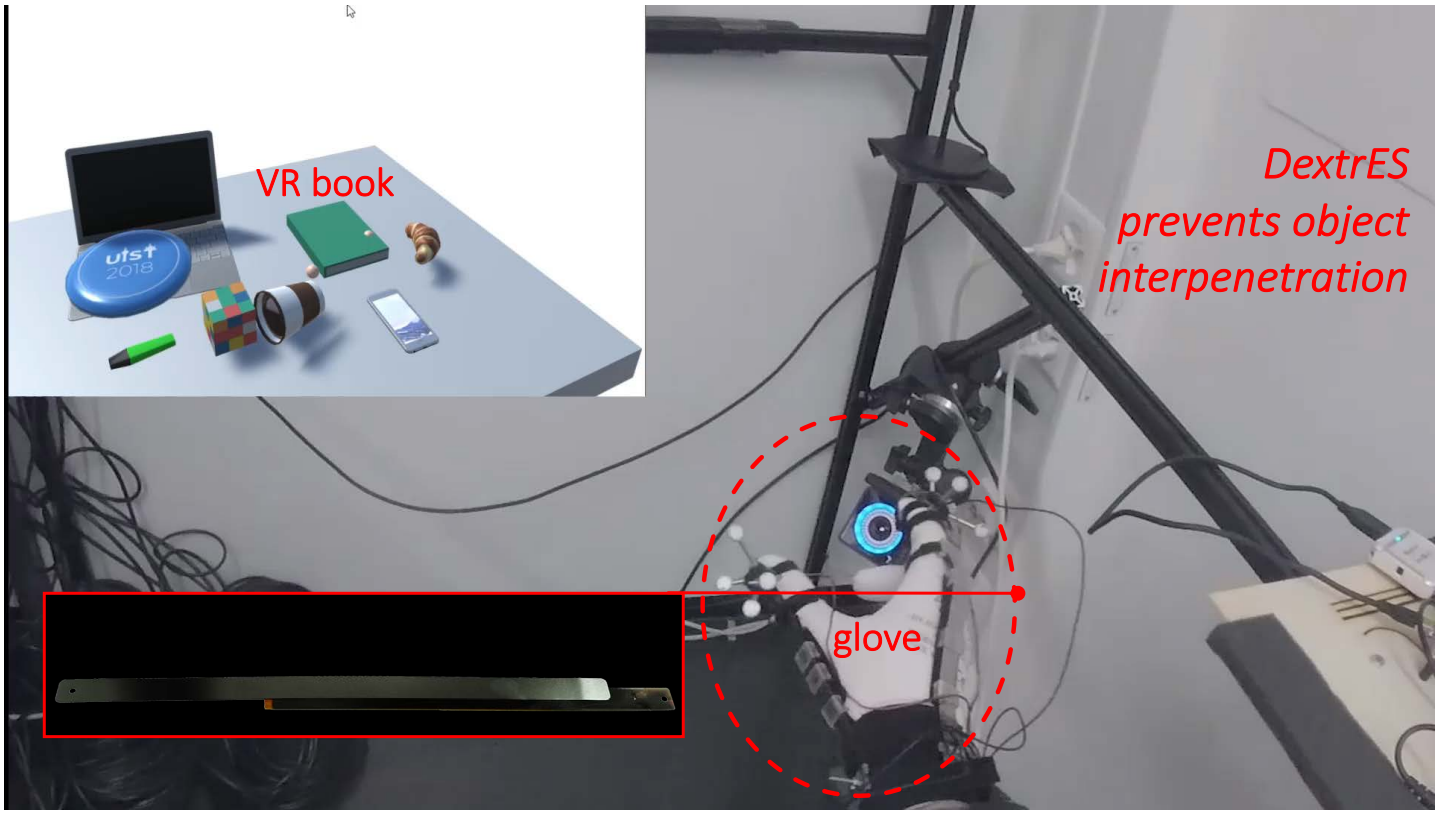
very slim form-factor
does not hinder finger motion when off



ETH zürich

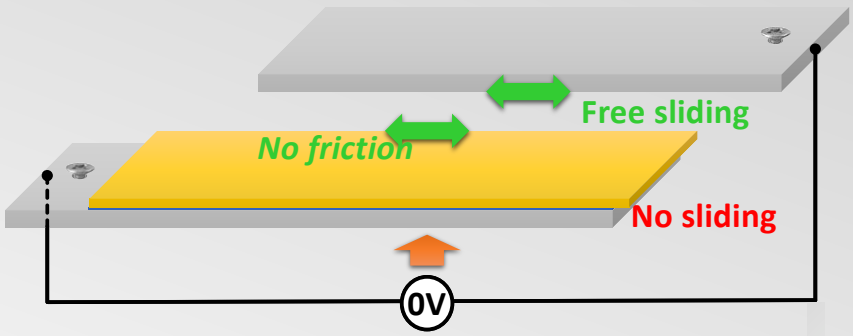
https://www.dextarobotics.com/

https://haptx.com/



EPFL ETH zürich

How does the ES clutch block motion?



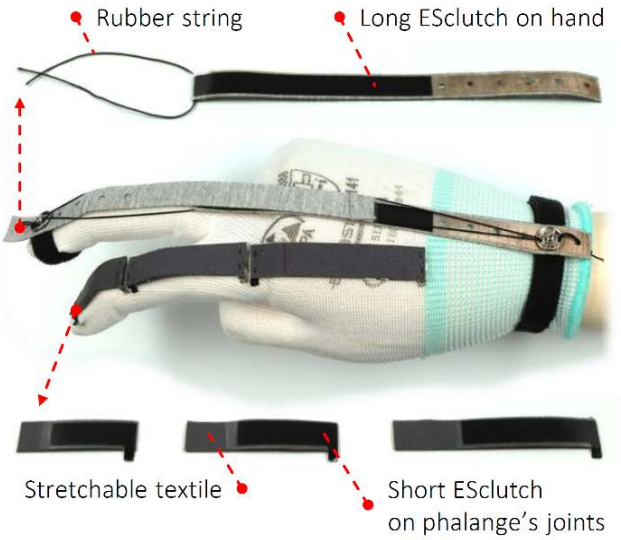
No voltage

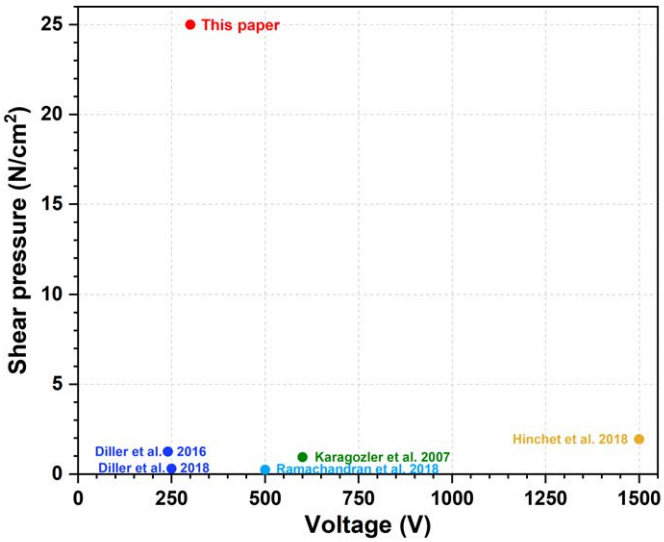
➢ Finger is free

High voltage

➢ Finger is blocked

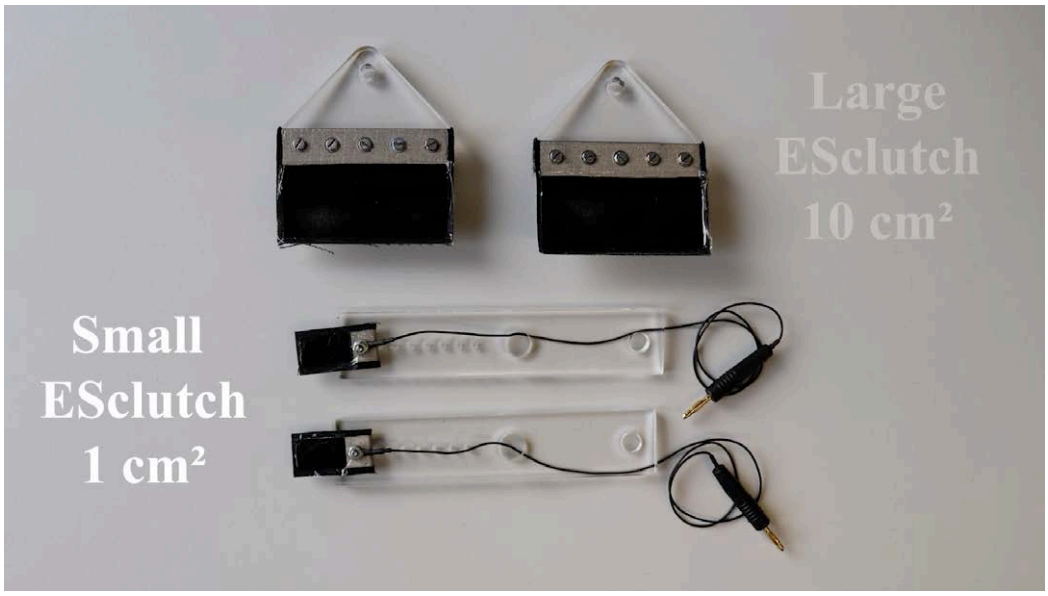
Now a new Textile version of the clutch: 10x higher force, 5x lower voltage, fully compliant





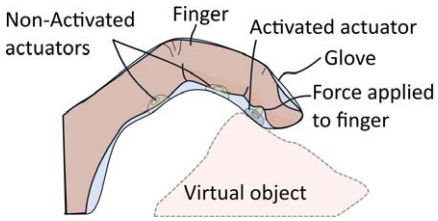
can block small joints and high force joints
power: less than 2 mW / cm²

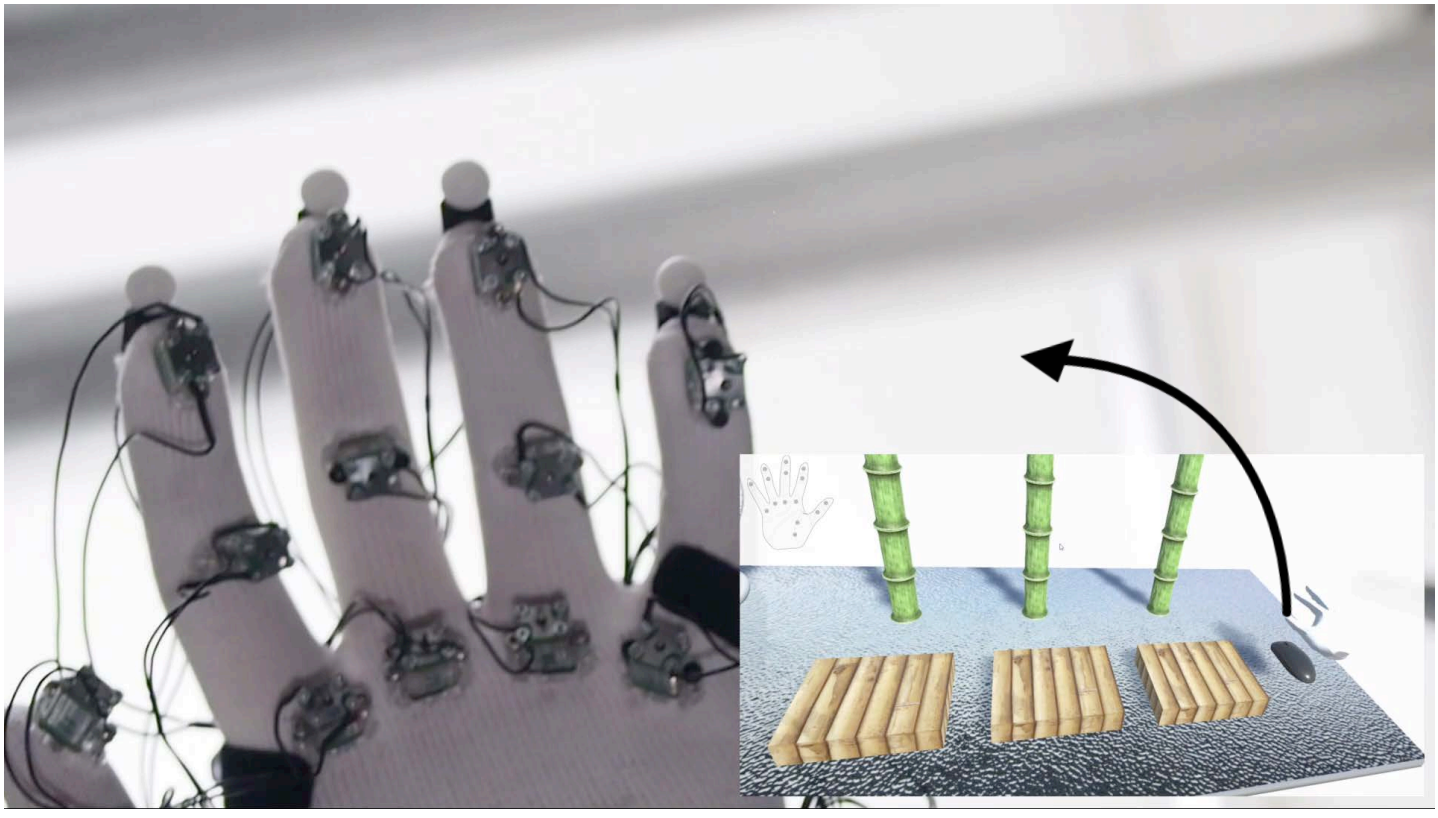
Our gen. 2 textile ESclutch can block 2 kg/cm² at 300V



this unrivalled performance enables a broad range of haptics applications in exoskeletons and full-body haptics

2. Tactiles: arrays of fast small pins to provide detailed and realistic sense of touch on fingers and hand





Designed for Notifications

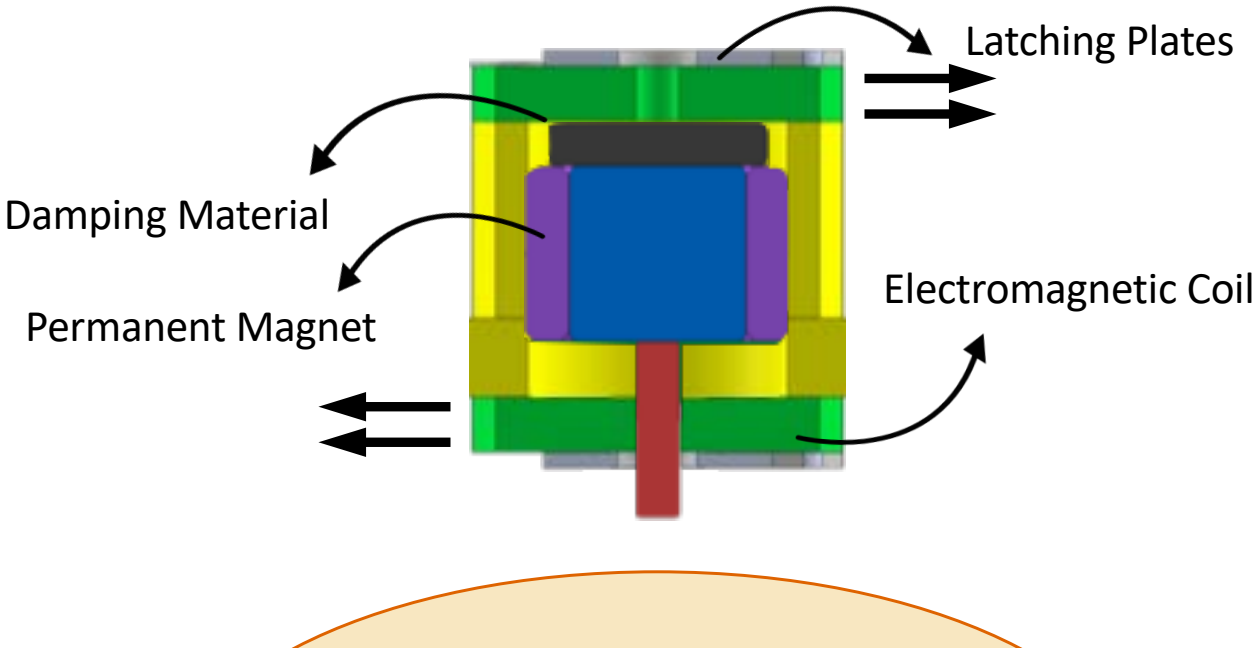
Designed for VR Touch

[Pece et al. MagTics]

[TacTiles]

Render **realistic tactile** feedback for **extended periods** of time in a **light and conformal** interface

No further power necessary



EPFL ETH zürich

50%
Size & Weight
1cm ^{3} 1.8g

8x
Less Power

2Hz
Per second
Sustained

200Hz
Per second
Burst

EPFL ETH zürich

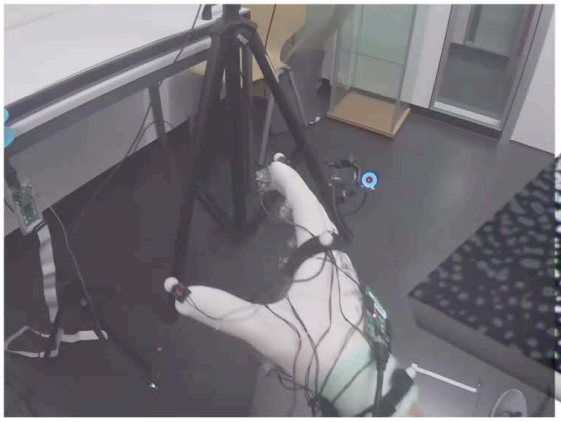
Pulse

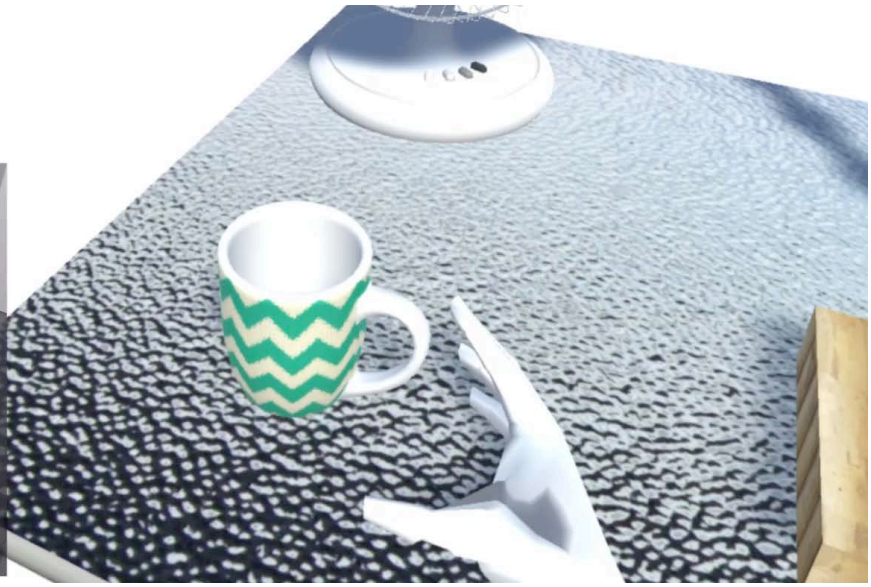
Contact

Modes and Applications

Linear ↓ Linear → Radial ↓ Radial ←

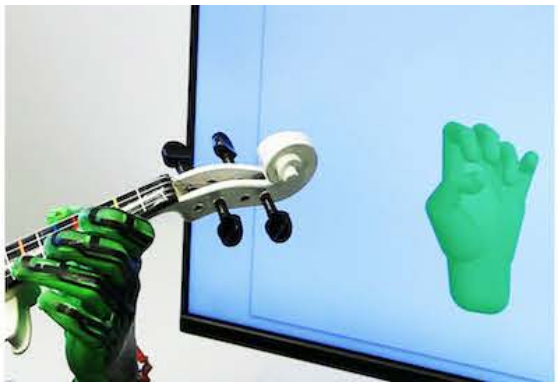
Pulse Mode Contact Mode ✓

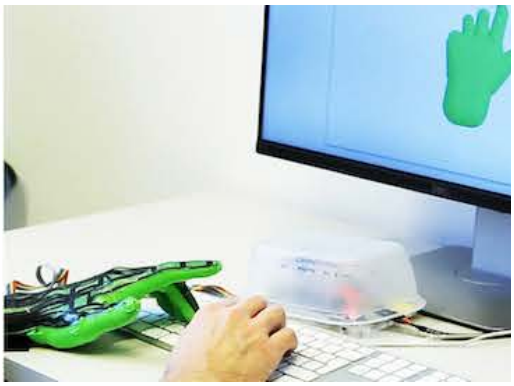




EPFL ETH zürich

3. Pose Sensing glove





fully stretchable distributed strain sensor to provide continuous information on hand pose

Publications / Conferences

We publish in Conferences with acceptance rate of order only 20%

- UIST 2017
- UIST 2018
- IEEVR 2019
- Preparing submission to SIGGRAPH 2020

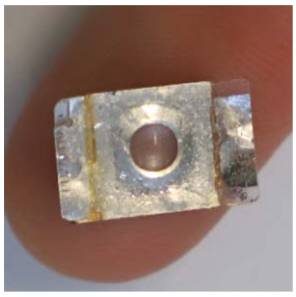
- ACM Transaction on Graphics
- Patent filing on the flexible clutch

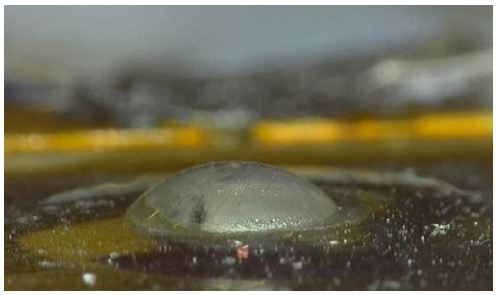
Outlook

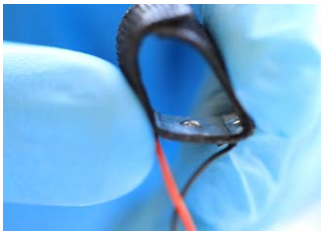
Our main challenges for next year:

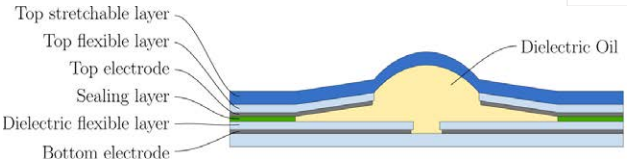
1. Softer, higher density, more integrated cutaneous actuators
2. Efficient sizing of clutch for different body parts and for different people
3. Integration of both clutch and cutaneous actuators into one glove / sleeve /suit

New cutaneous actuators:
Soft hydraulically amplified dielectric actuators









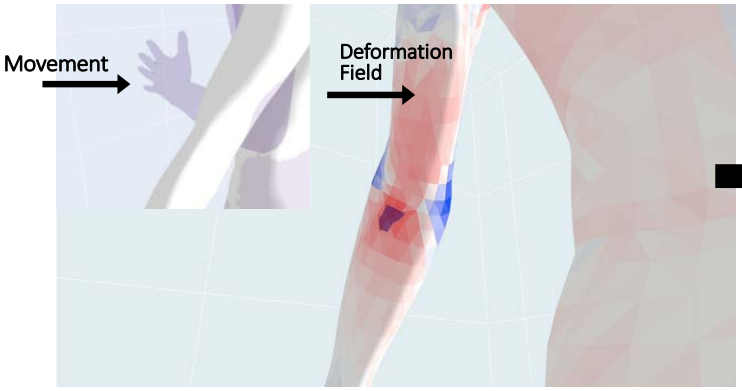
- Actuator **diameter of 3 mm**
- Force of **400 mN**
- Large **displacement: 500 µm**
- Fast and compatible with **vibrations** up to hundreds of Hz
- scalable to array
- can be extended to generate shear forces

towards a haptic sleeve

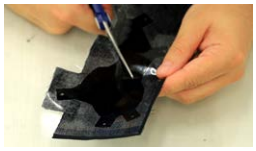
ES clutch: adapting it to block any joint on any body

Starting with a **specific movement** of the human body, we calculate the **primary strain** components and produce and **optimal** clutch design with a particular **area budget**.

$$\underset{\phi(\tau)}{\operatorname{argmin}} = \underbrace{-\lambda_1 W_{\text{stretch}}(\tau, a_i)}_{\text{Deformation}} + \underbrace{\lambda_2 R_{\text{area}}(\tau, a_i)}_{\text{Max Area}} + \underbrace{\lambda_3 R_{\text{gc}}(\tau, v_i)}_{\text{Gaussian Curvature}} + \underbrace{\lambda_4 R_{\text{bound}}(\tau, e_i)}_{\text{Boundary Length}}$$



Fabrication of complex ESclutch shape with large surfaces integrated onto skin



Actuator for Movement

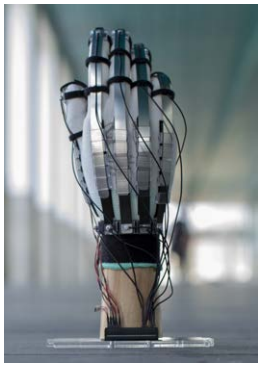
to full-body haptics

EPFL

ETH zürich

Our sincere thanks to the Hasler Foundation for funding this research

Thank you for your attention!



Contact Info:

Prof. Herbert Shea (herbert.shea@epfl.ch)
EPFL-LMTS

Prof. Otmar Hilliges (otmar.hilliges@inf.ethz.ch)
ETHZ-AIT