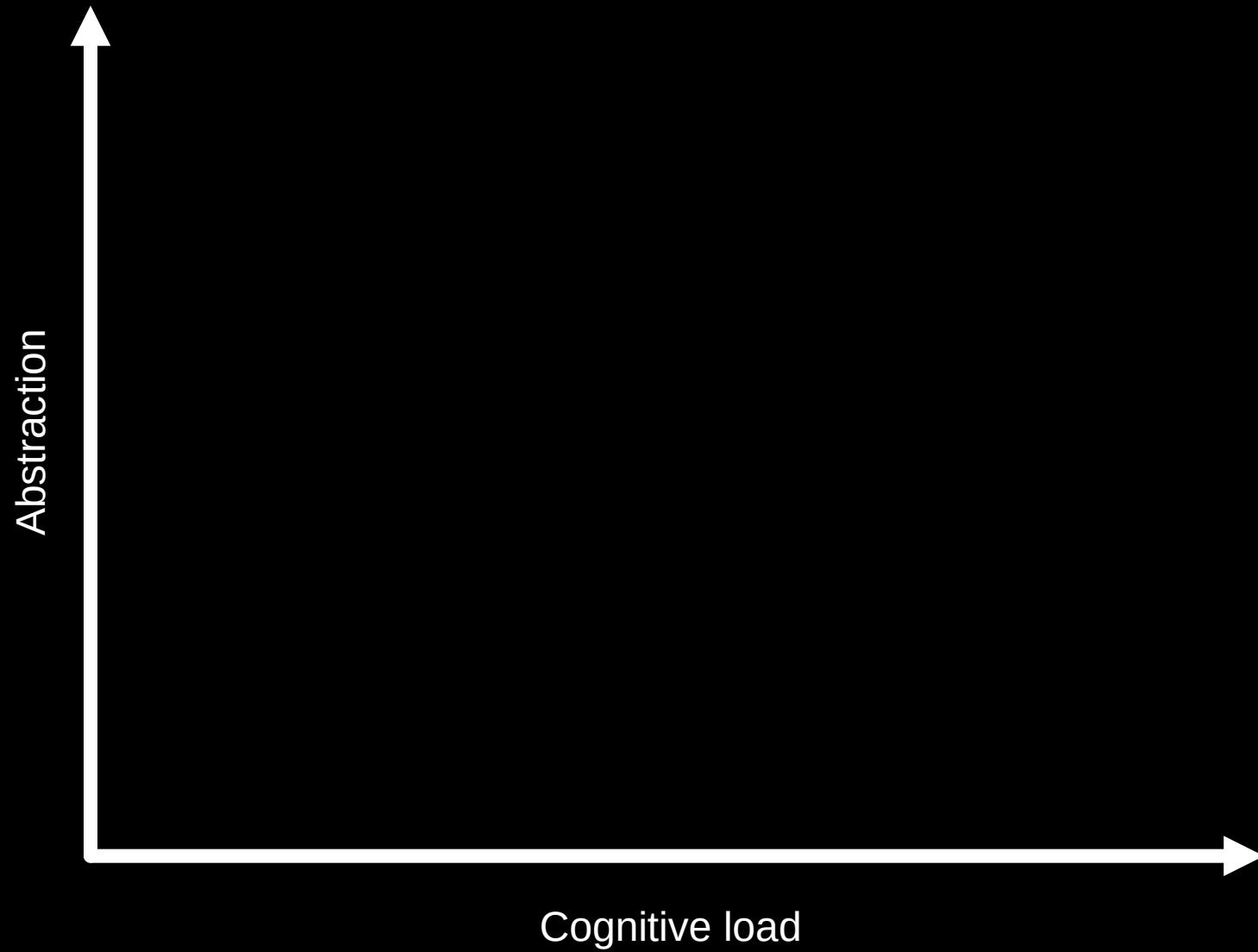


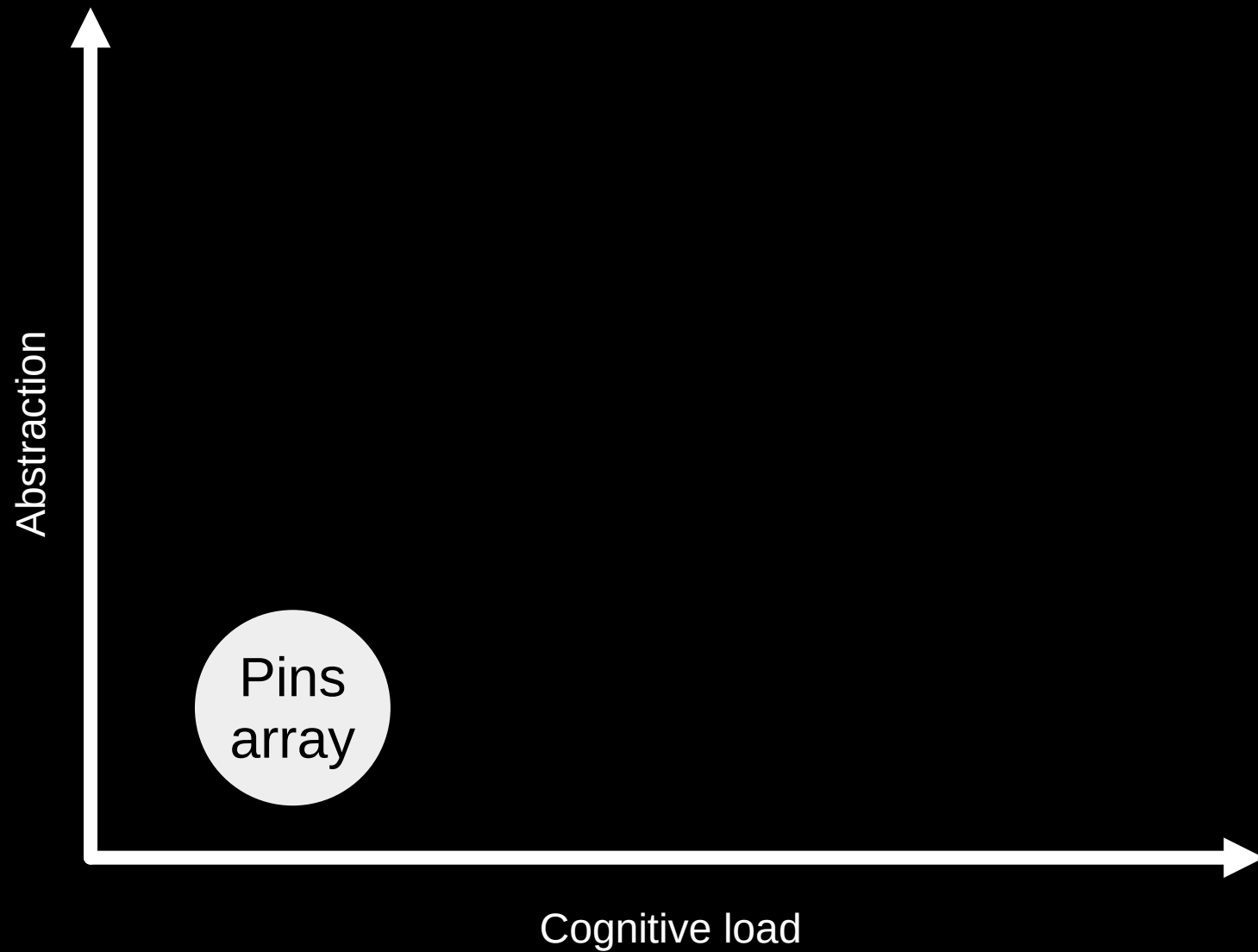
stimulate the sense of touch

*Frédéric Giraud, Betty Semail, Christophe Giraud-Audine, Angelica Torres
Jean-Luc Bruyelle*

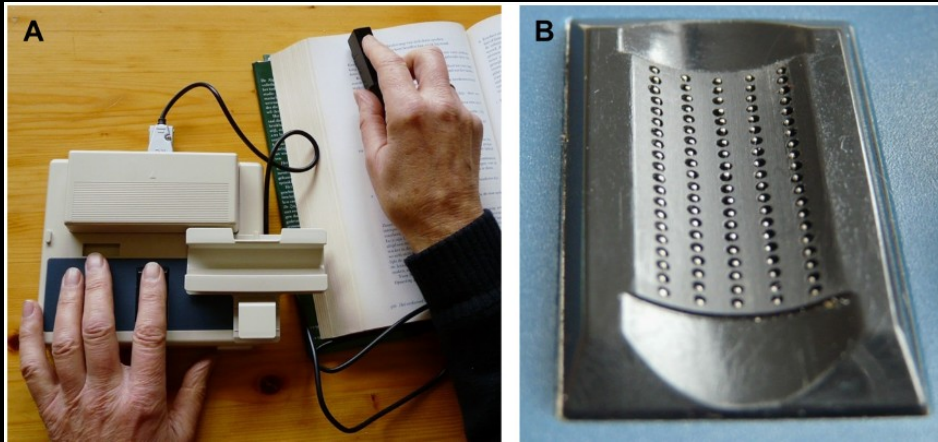
*Université de Lille, Laboratoire L2EP
Membre de l'axe « interfaces tactiles et gestuelles » de l'IRCICA*

- Pins array
- Vibrotactile
- Button click
- Haptic Surfaces

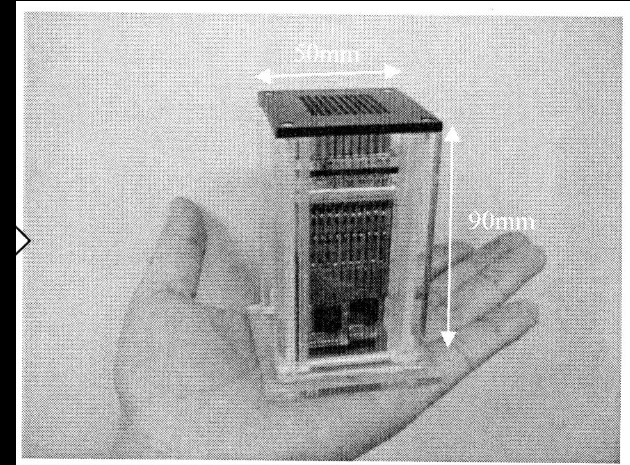




Pins array



Optacon, telesensort systems (discontinued in 2000)

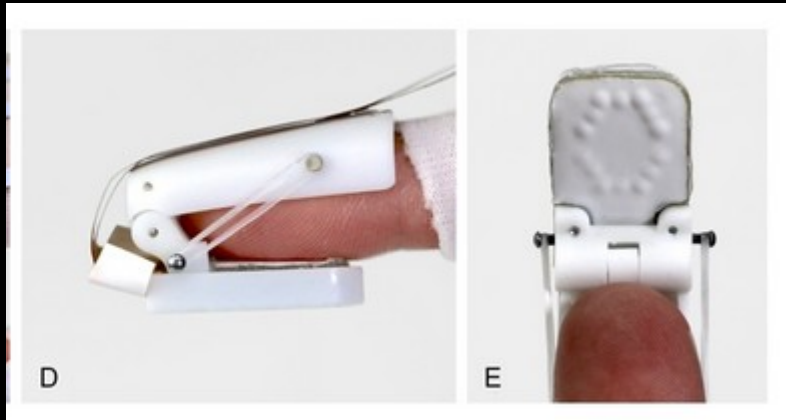


T. Matsunaga, K. Totsu, M. Esashi and Y. Haga, "Tactile display for 2-D and 3-D shape expression using SMA micro actuators," 2005

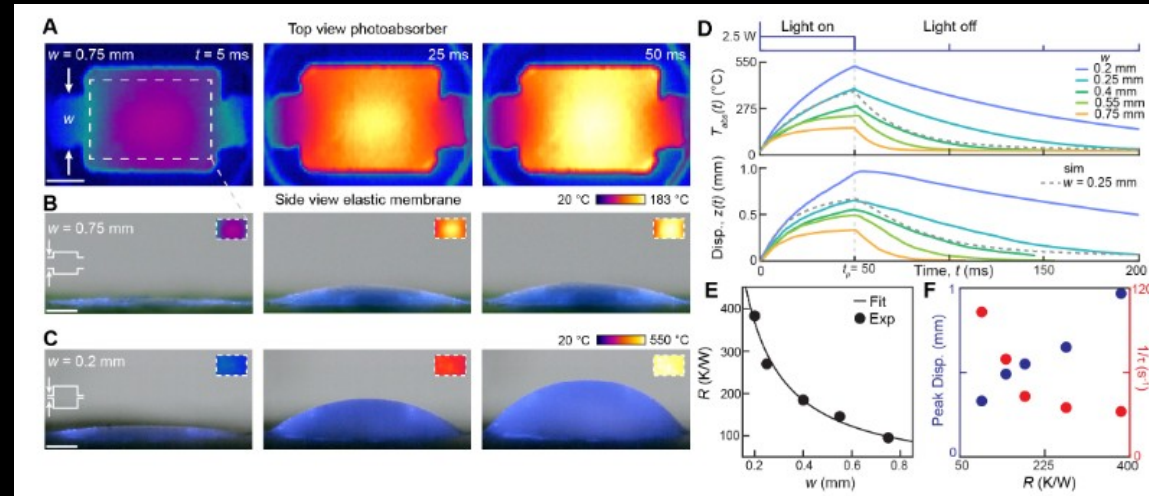


A dense array stimulator to generate arbitrary spatio-temporal tactile stimuli JH Killebrew, SJ Bensmaia, JF Dammann... - Journal of neuroscience ..., 2007 - Elsevier

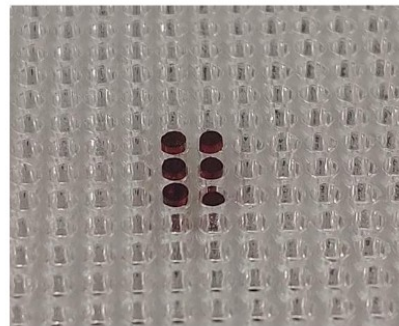
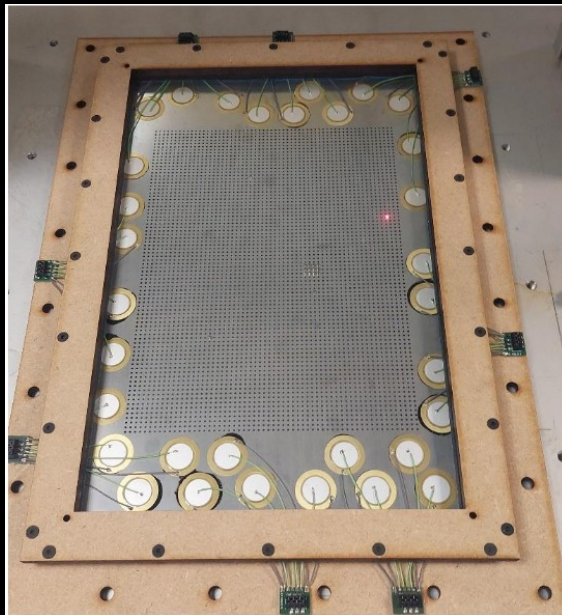
Pins array



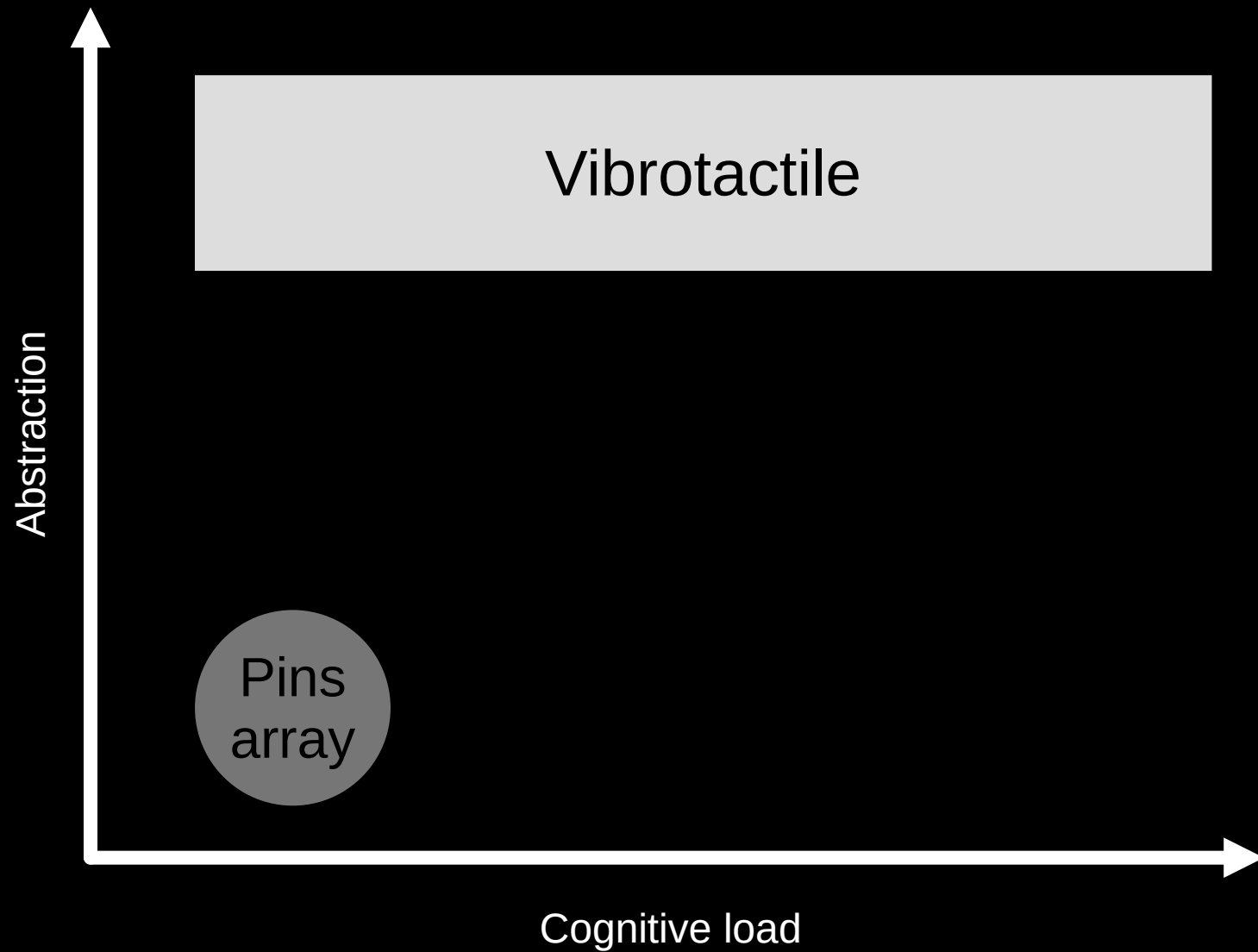
Vivian Shen & al 2023. Fluid Reality: High-Resolution, Untethered Haptic Gloves using Electroosmotic Pump Arrays.



Max Linnander et al. Tactile displays driven by projected light. Sci. Robot.10,eadv1383(2025)



M. Esteban & al, "Reducing the Number of Actuators in Braille Displays with Time Reversal Focusing," 2025



Vibrotactile arrays

Haptic Language



van Veen, H et al (2001): Tactile information presentation in the cockpit.



TeslaSuit

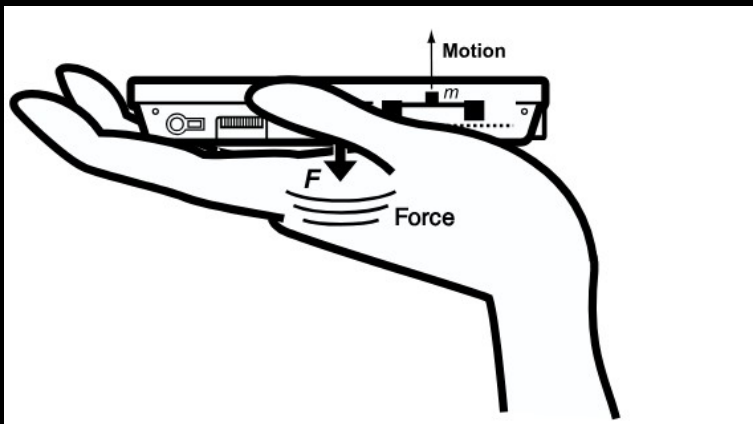
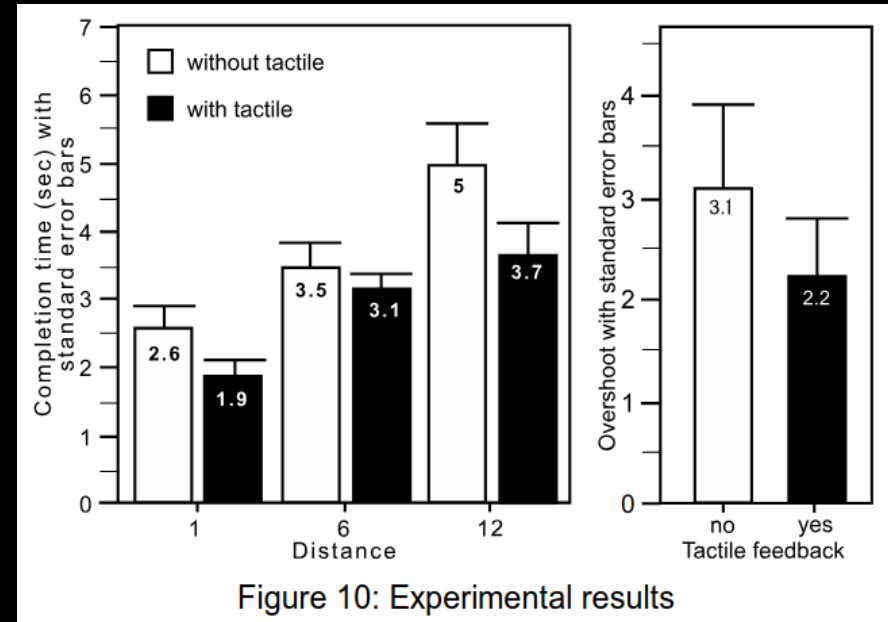


Razer

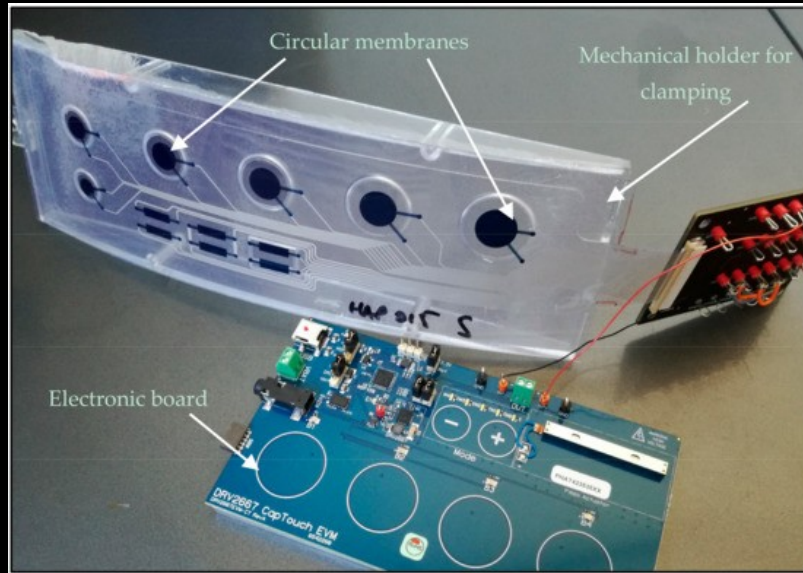
Vibrotactile actuator



Ivan Poupyrev et al Ambient touch: designing tactile interfaces for handheld devices. 2002



Vibrotactile actuator



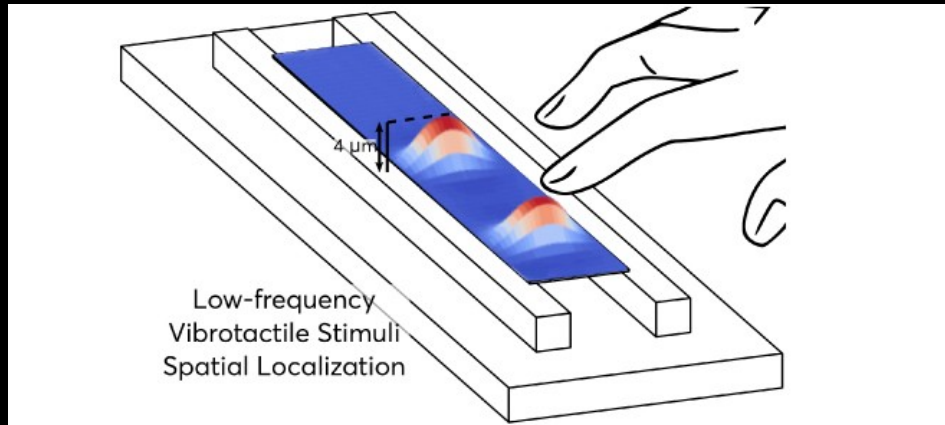
Poncet, P. et al Emery, P.; Fanget, S. Static and Dynamic Studies of Electro-Active Polymer Actuators and Integration in a Demonstrator



<https://www.innovobot.com>

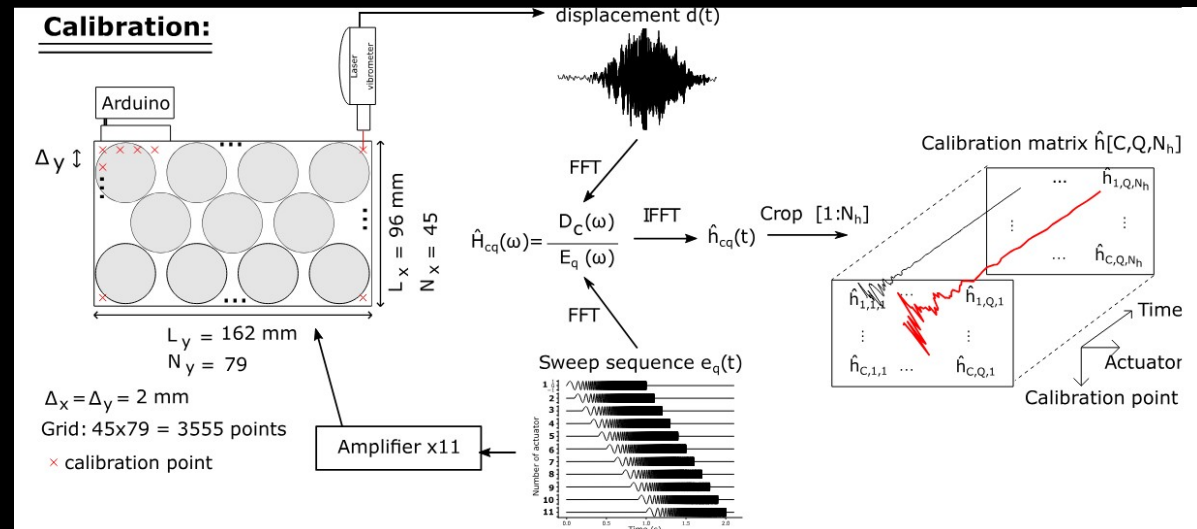
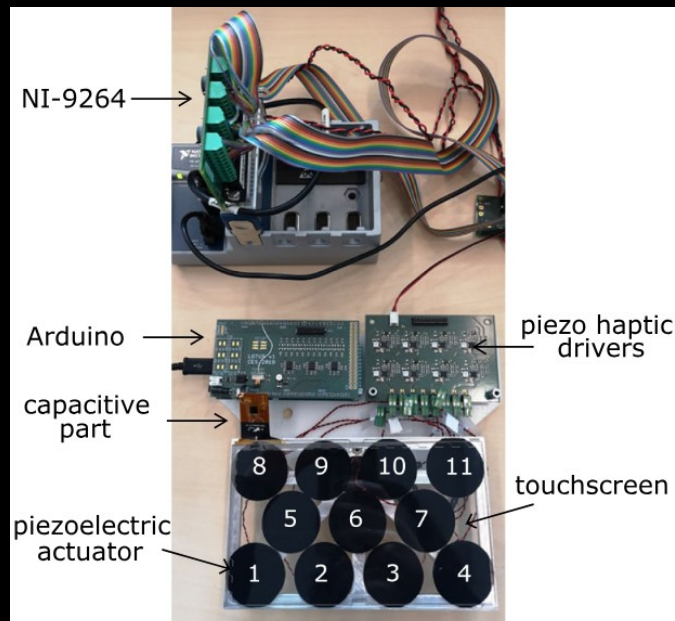
Vibrotactile actuator

Advanced design (confinement)



A. B. Dhiab et al "Confinement of Vibrotactile Stimuli in Narrow Plates: Principle and Effect of Finger Loading,"

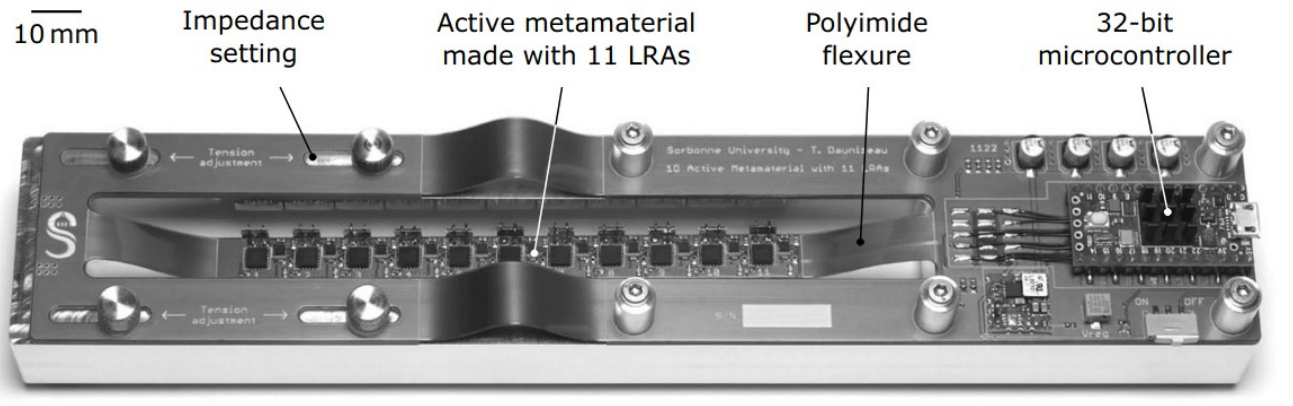
Advanced control (Inverse filtering)



L. Pantera et al Multitouch Vibrotactile Feedback on a Tactile Screen by the Inverse Filter Technique: Vibration Amplitude and Spatial Resolution 2020

Vibrotactile actuator

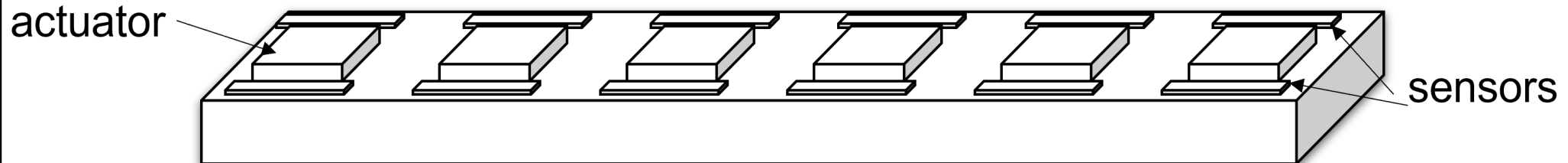
metamaterials



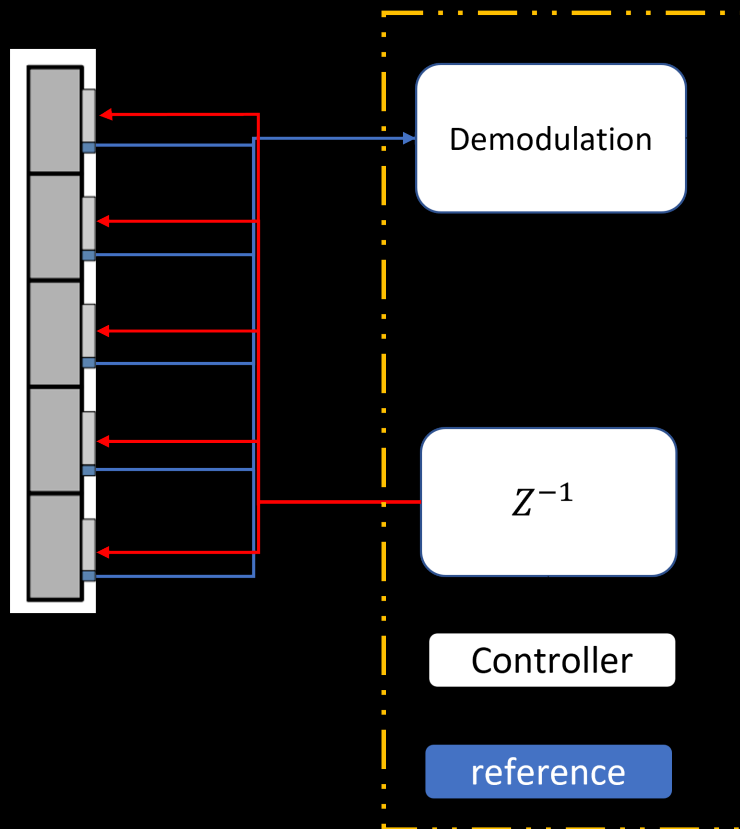
Daunizeau, T., Haliyo, S., Gueorguiev, D., & Hayward, V. (2025). Dynamic shaping of multi-touch stimuli by programmable acoustic metamaterial

Vibrotactile actuator

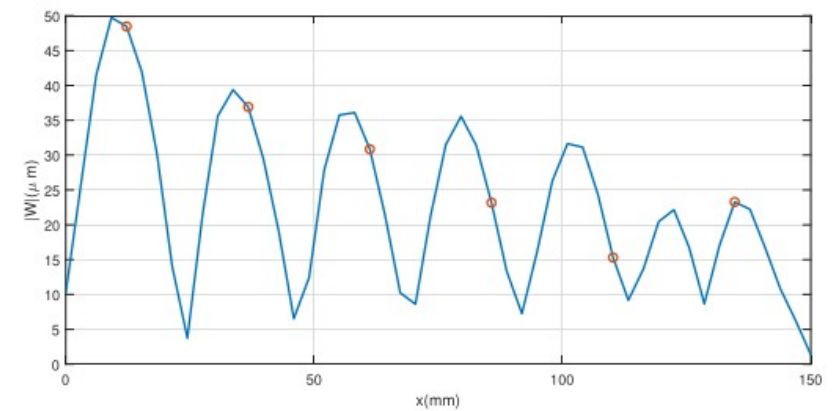
metamaterials



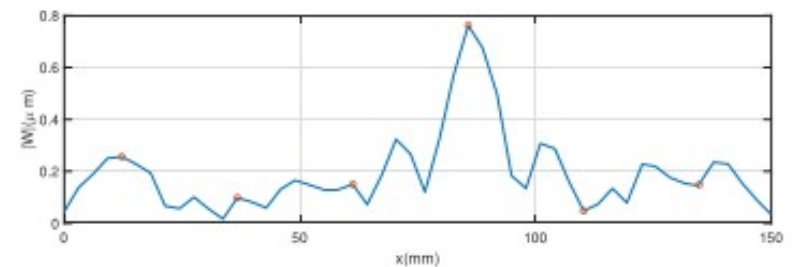
M. Ouari, thèse de Doctorat Ulille 2025 Conception d'ondes mécaniques localisées contrôlées : application à l'haptique

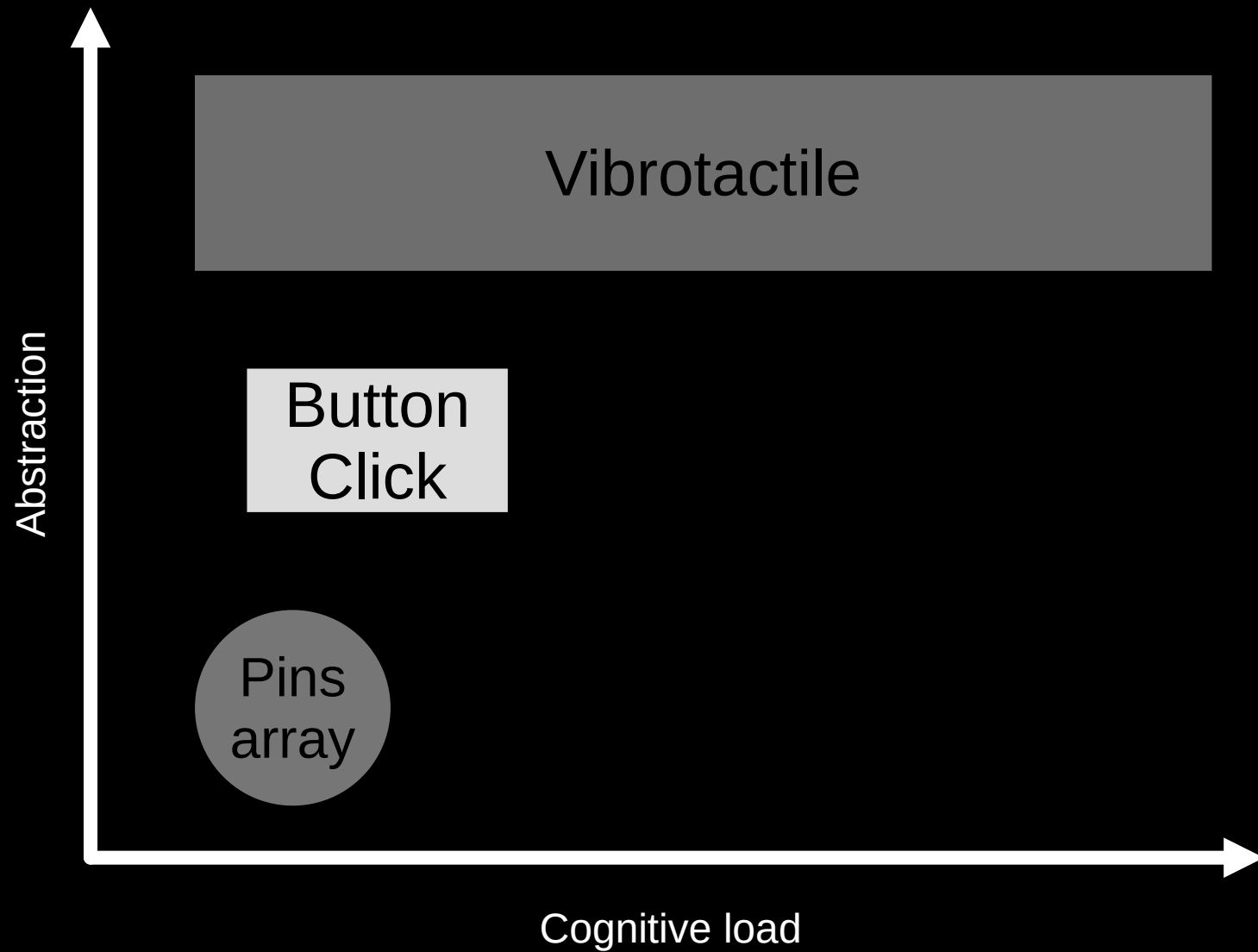


Without Control

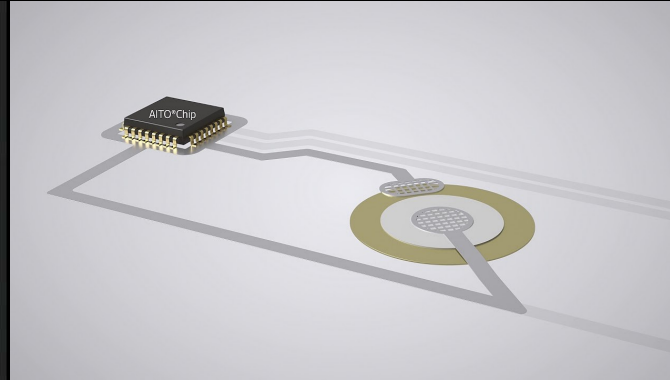


With closed loop control



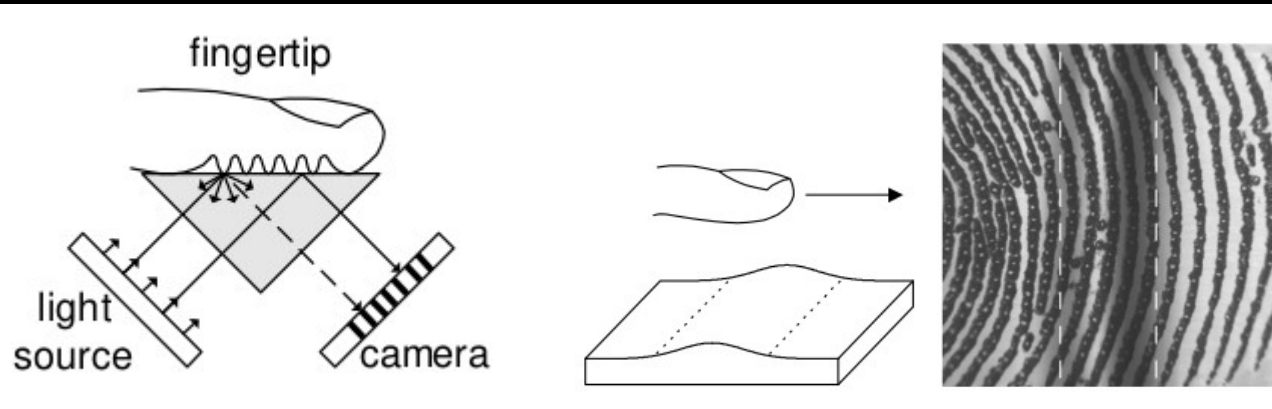


Vibrotactile buttons

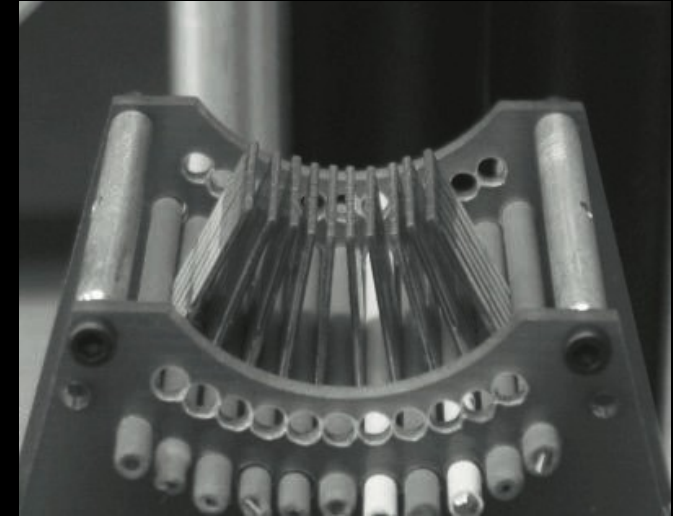


aito

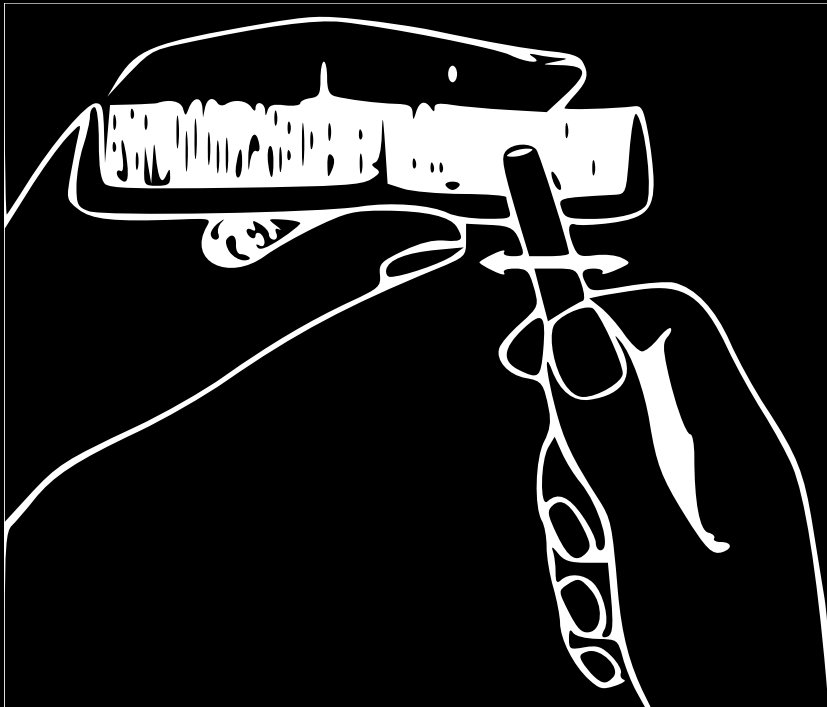
The Comb Illusion



Experimental Evidence of Lateral Skin Strain During Tactile Exploration Vincent Lévesque, Vincent Hayward Proc. Eurohaptics 2003, Dublin, Ireland, July 2003.

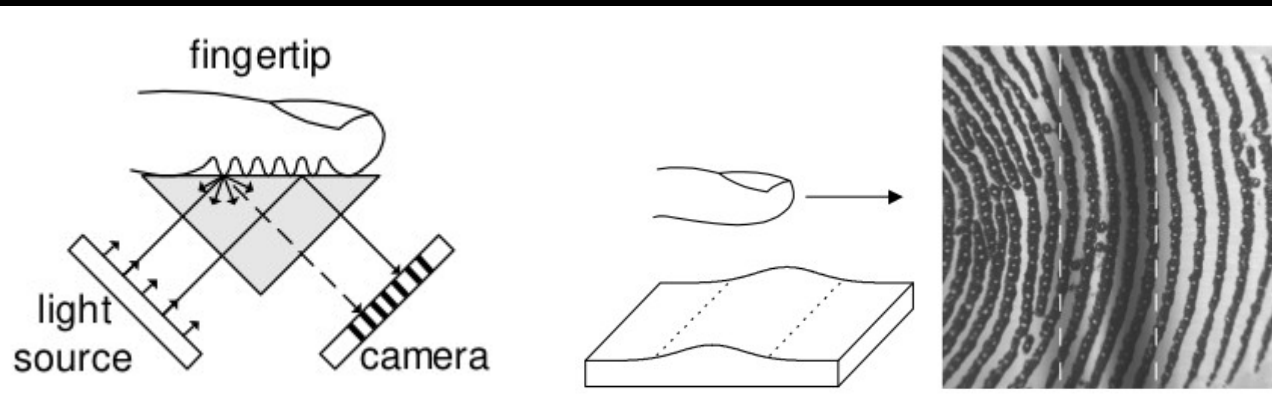


Pasquero, Jérôme and Vincent Hayward. "STReSS: A Practical Tactile Display System with One Millimeter Spatial Resolution and 700 Hz Refresh Rate." (2003).

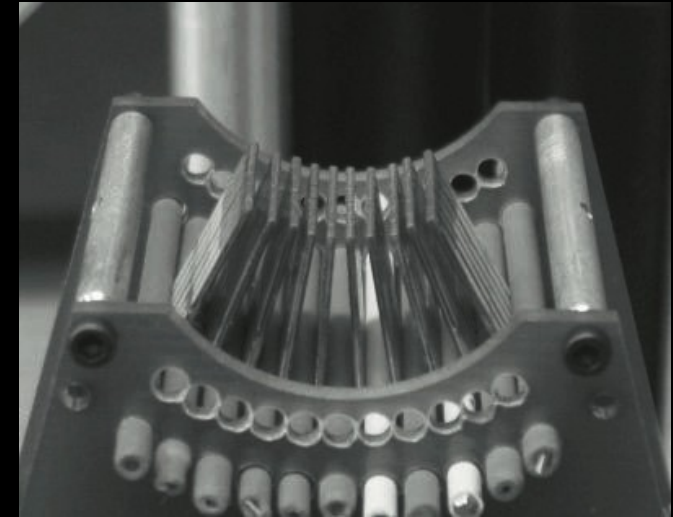


The "comb illusion"

The Comb Illusion



Experimental Evidence of Lateral Skin Strain During Tactile Exploration Vincent Lévesque, Vincent Hayward Proc. Eurohaptics 2003, Dublin, Ireland, July 2003.



Pasquero, Jérôme and Vincent Hayward. "STReSS: A Practical Tactile Display System with One Millimeter Spatial Resolution and 700 Hz Refresh Rate." (2003).

Letter | [Published: 26 July 2001](#)

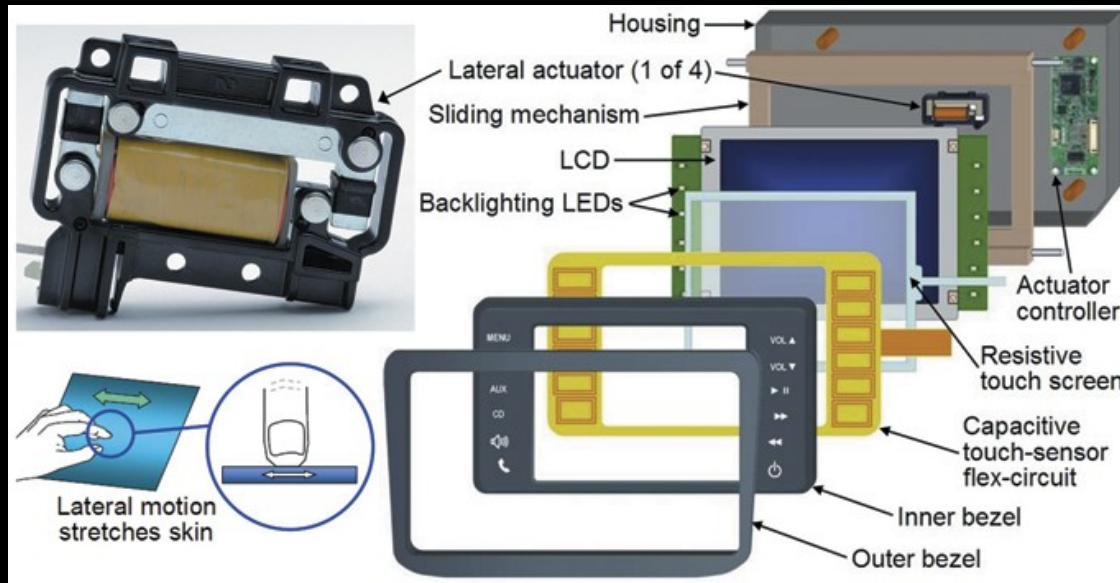
Force can overcome object geometry in the perception of shape through active touch

[Gabriel Robles-De-La-Torre](#) & [Vincent Hayward](#)

[Nature](#) **412**, 445–448 (2001) | [Cite this article](#)

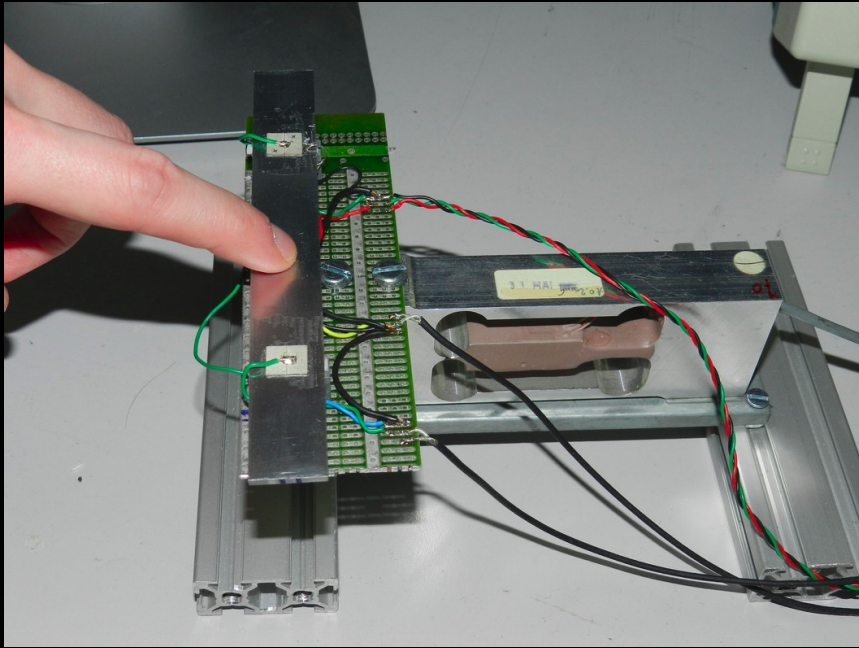
3357 Accesses | **270** Citations | **4** Altmetric | [Metrics](#)

Lateral skin stretches – low frequency

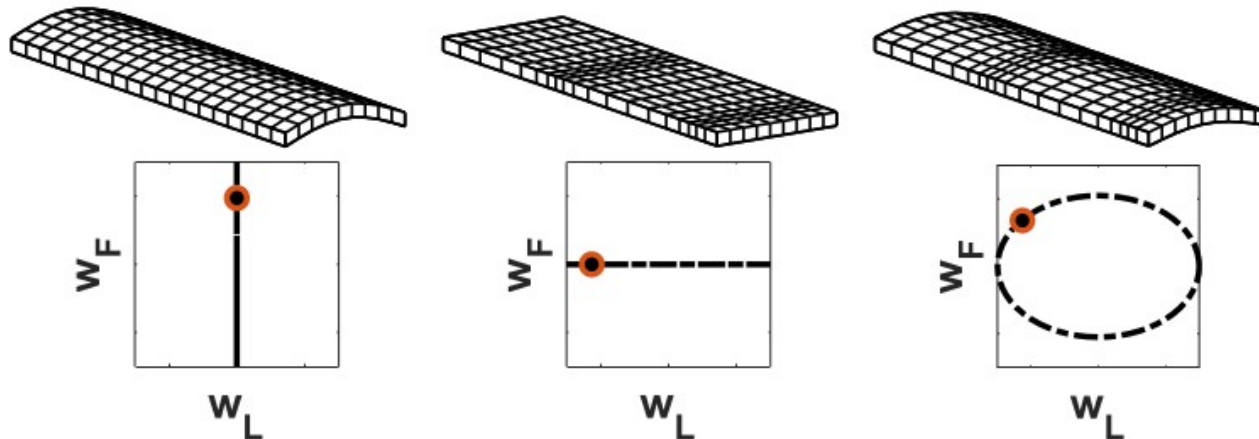
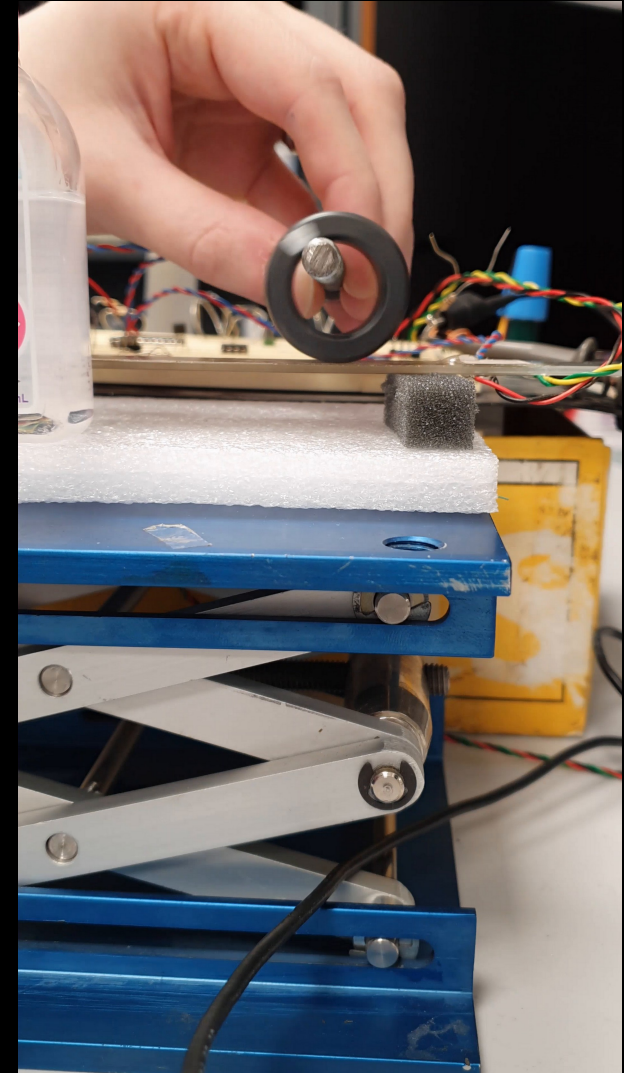


Immerstion A110 (2009)

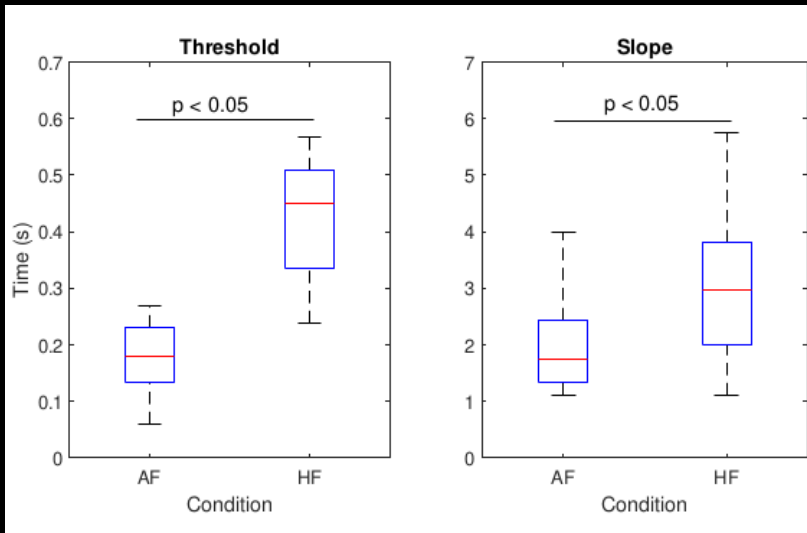
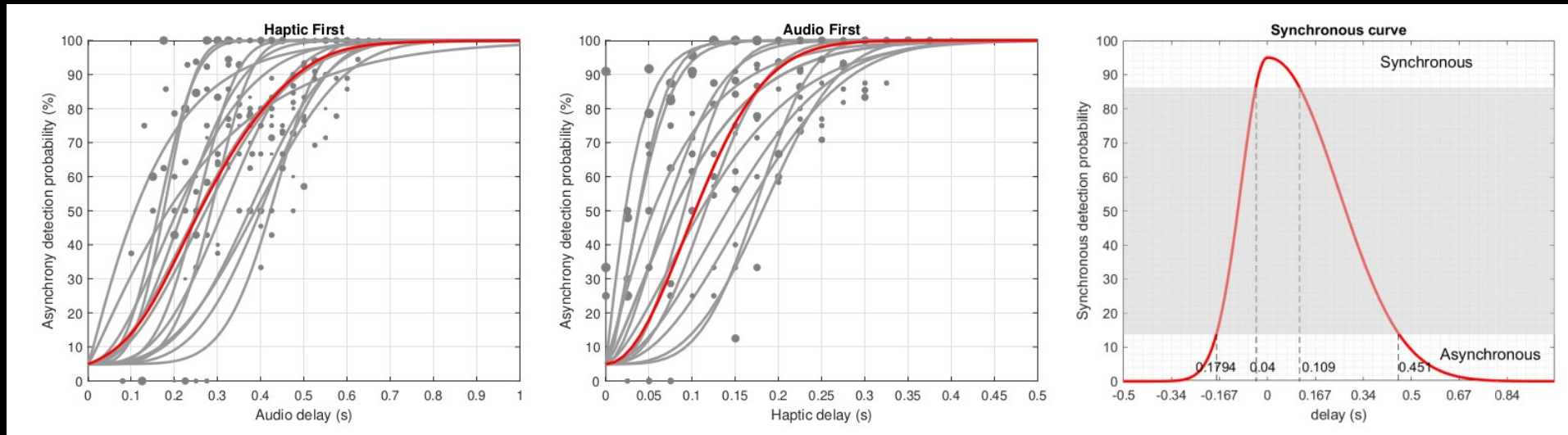
Lateral skin stretches – ultrasonically induced forces



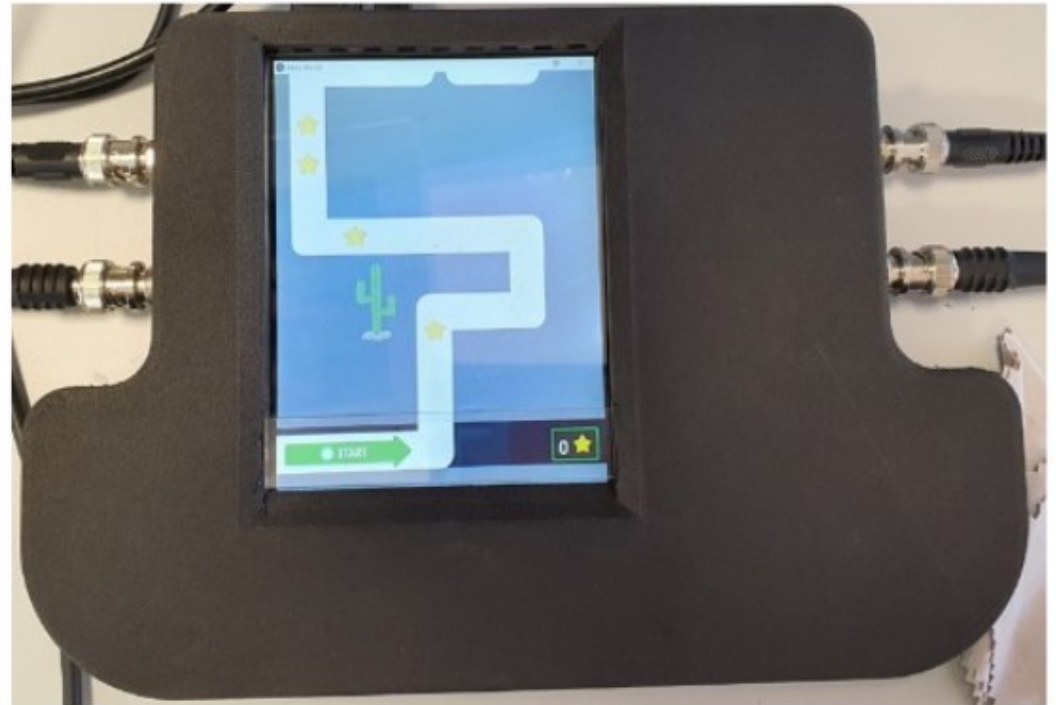
Control of an ultrasonic haptic interface for button simulation
P Garcia, F Giraud, B Lemaire-Semail, M Rupin, A Kaci
Sensors and Actuators A: Physical 342, 113624

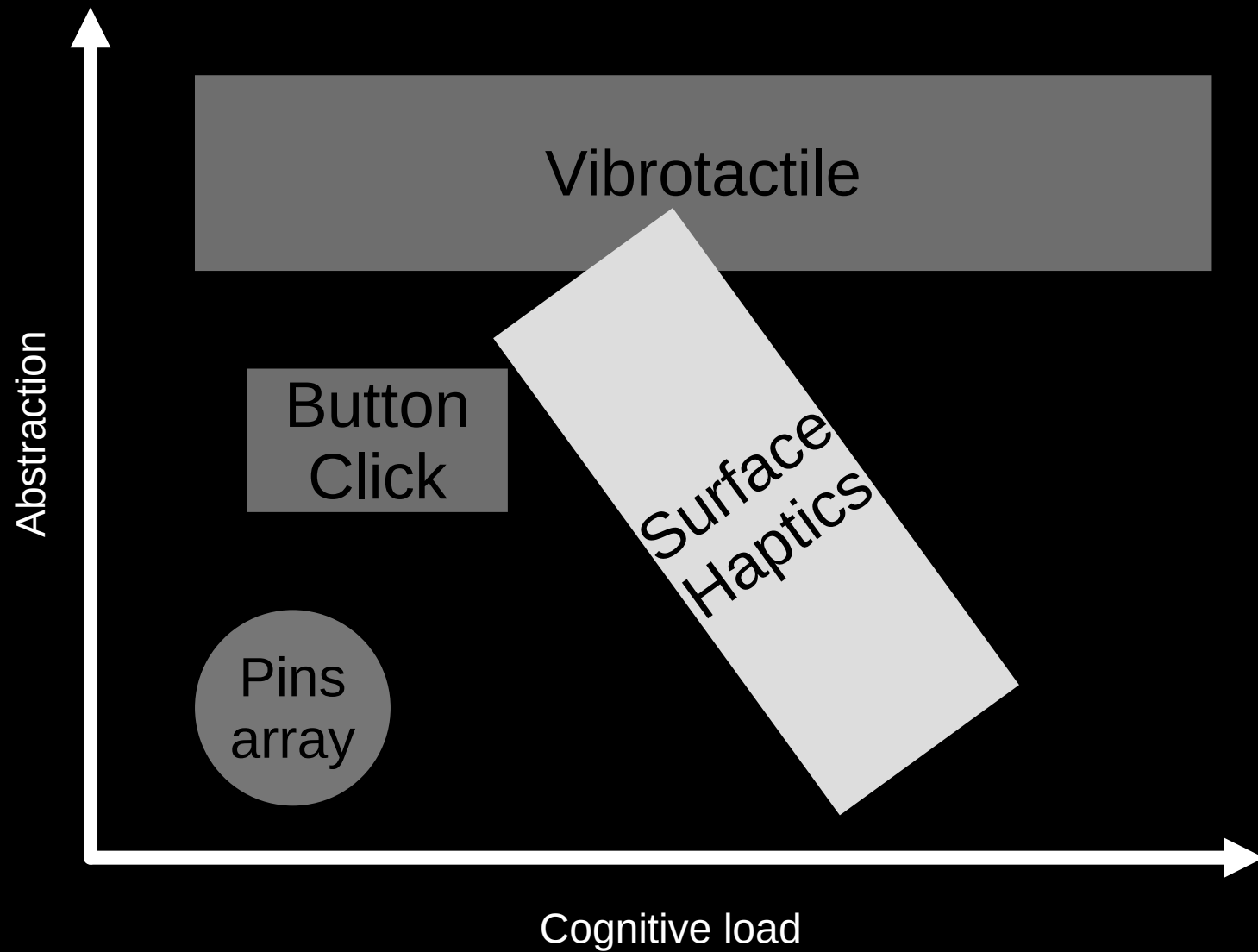


Lateral skin stretches – ultrasonically induced forces

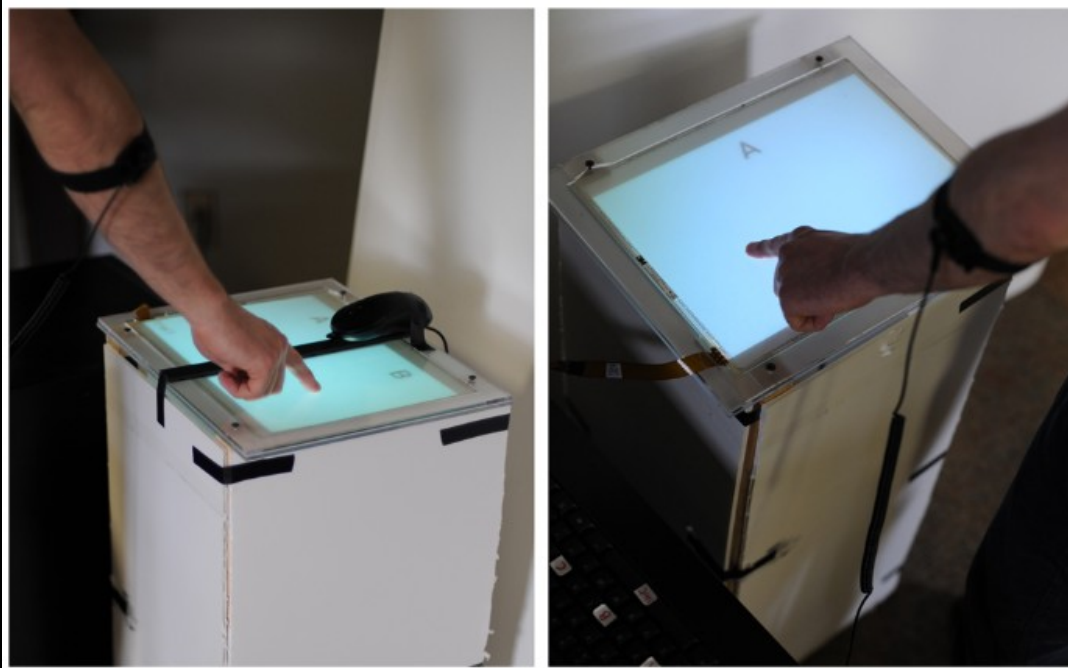


Garcia, P., et al. 2MoTac: Simulation of button click by superposition of two ultrasonic plate waves (2020)

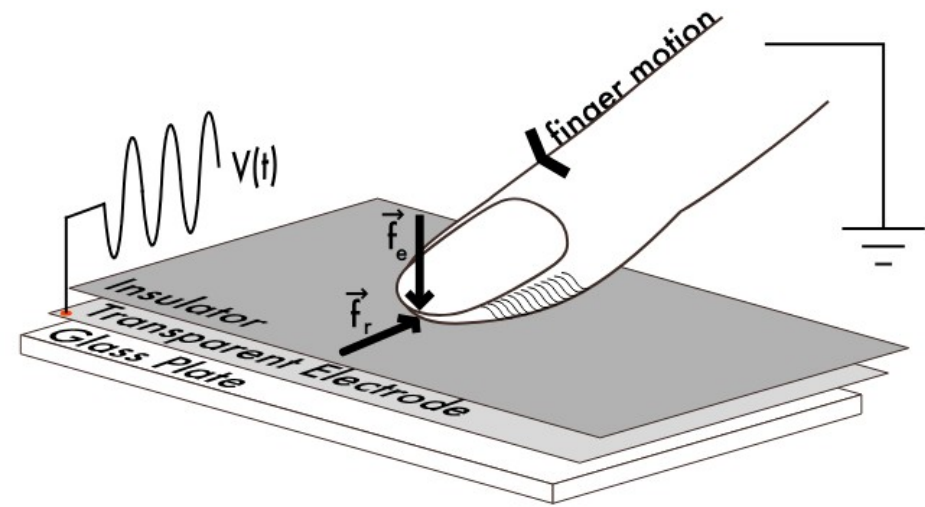




Friction controlled interfaces

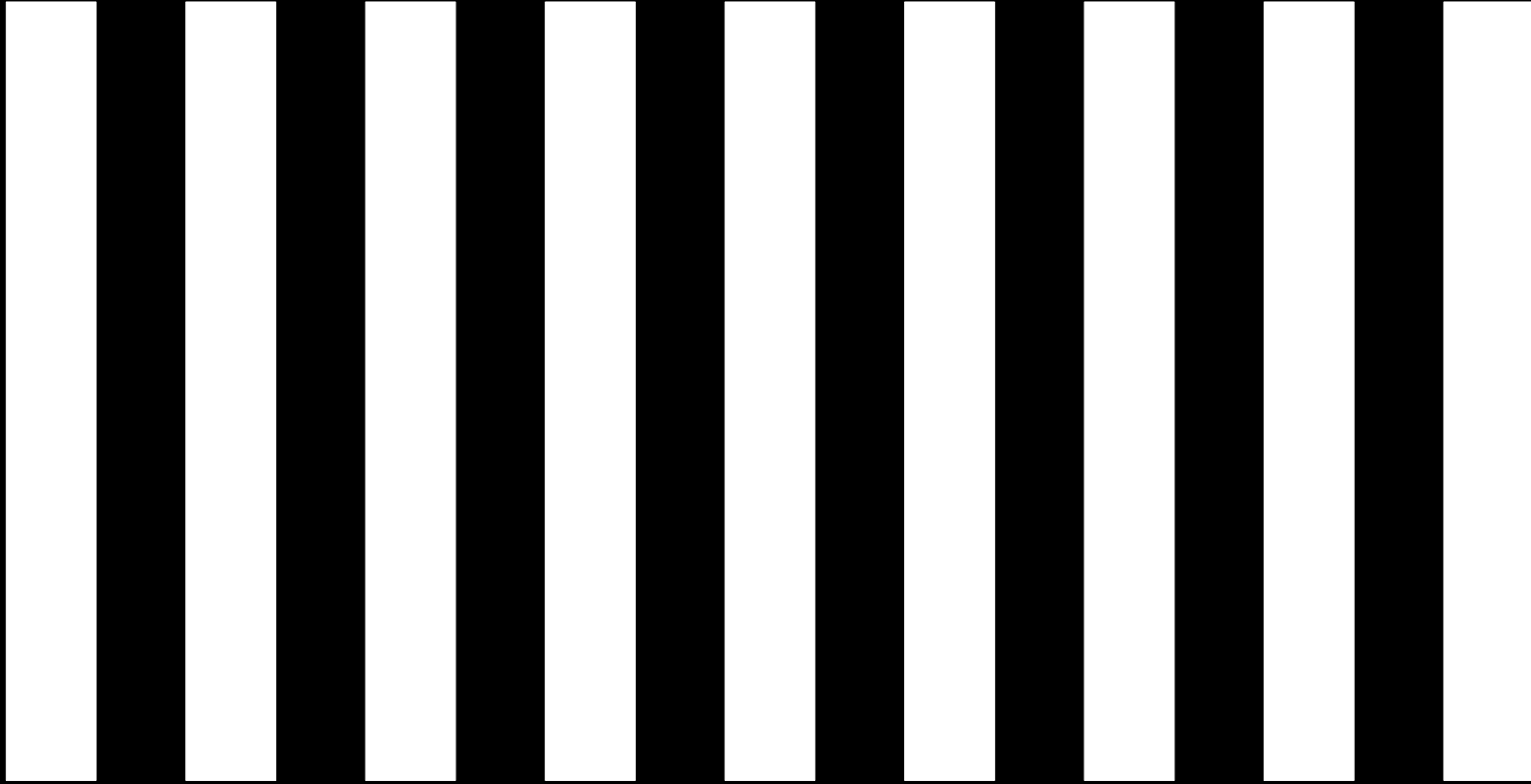


Bau, O., Poupyrev, I., Israr, A., & Harrison, C. TeslaTouch: electrovibration for touch surfaces. (2010)

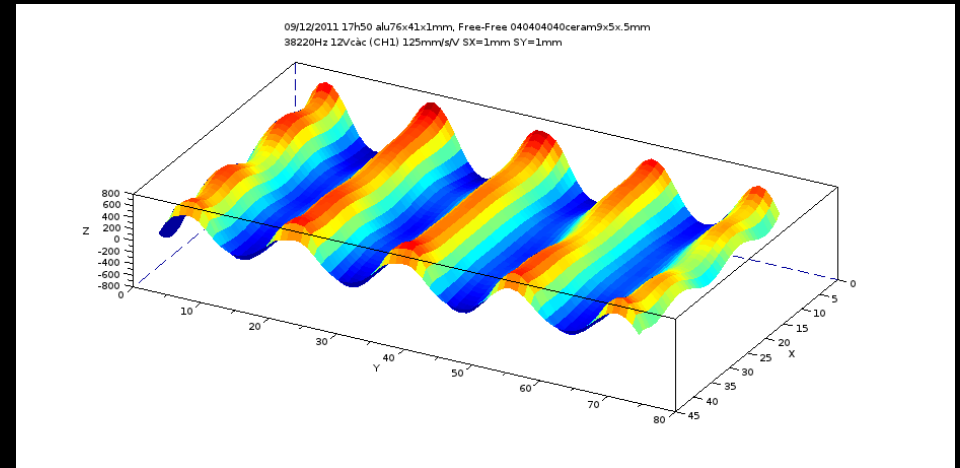
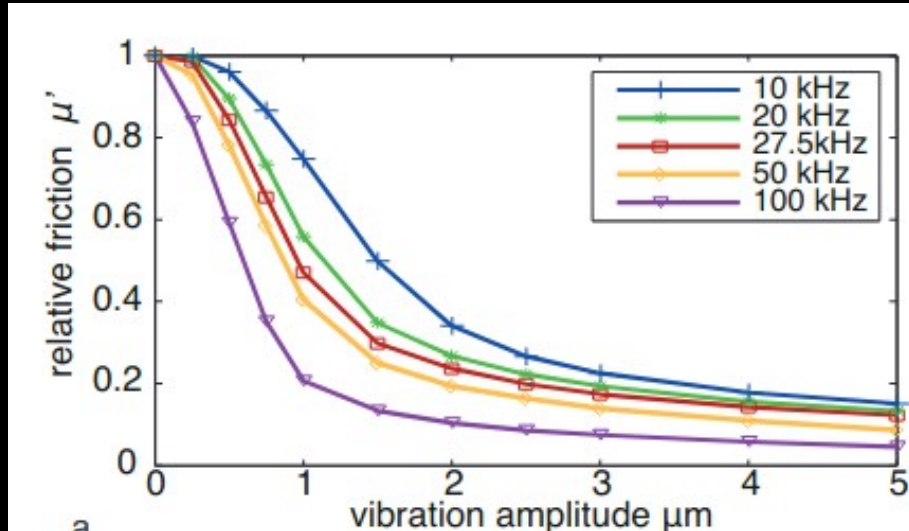
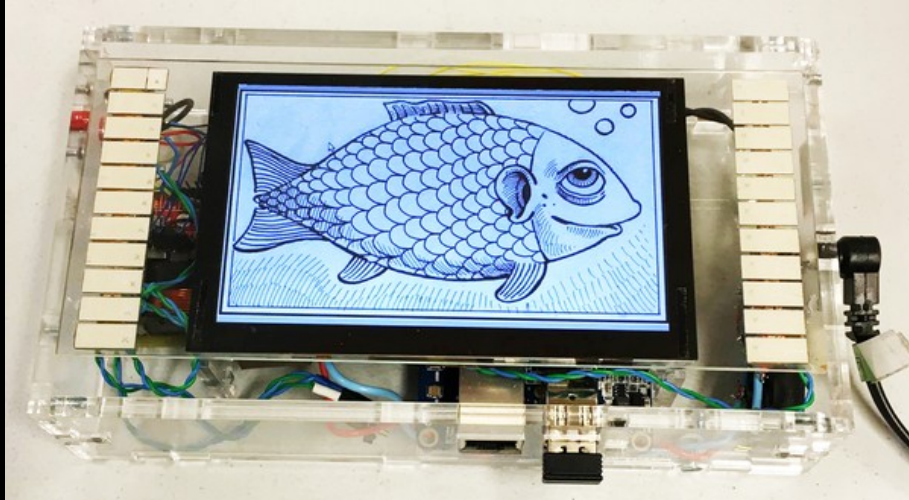


The tesla touch

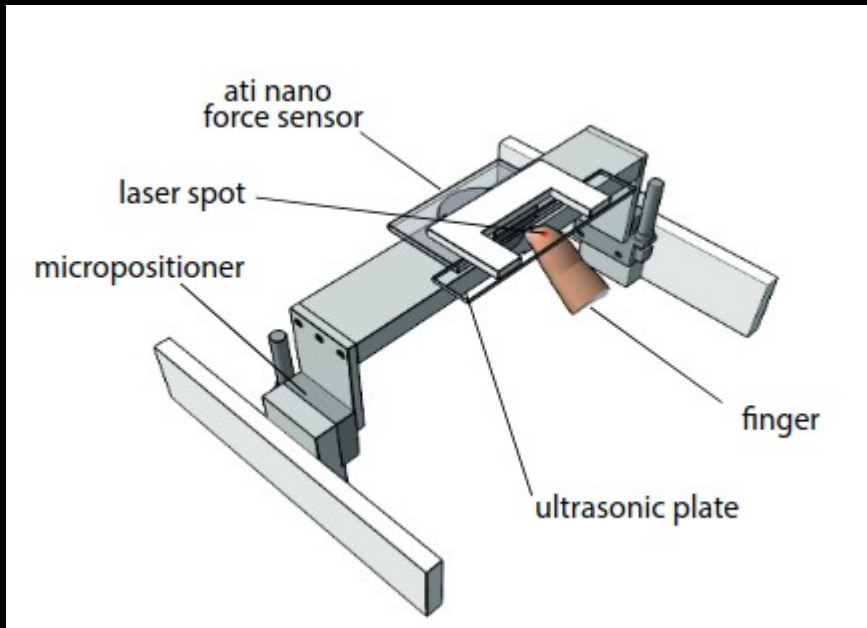
Friction controlled interfaces : the illusion



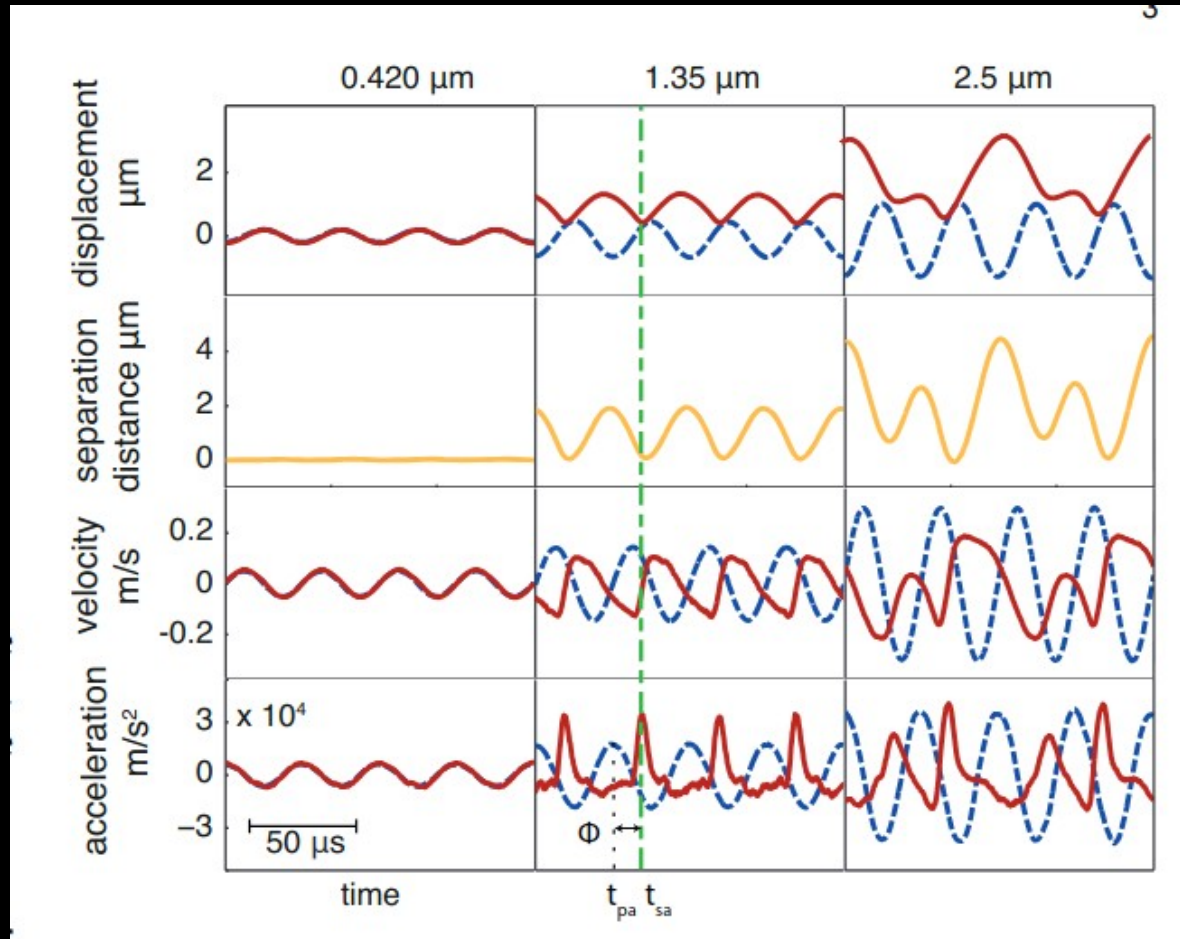
Ultrasonic Friction control



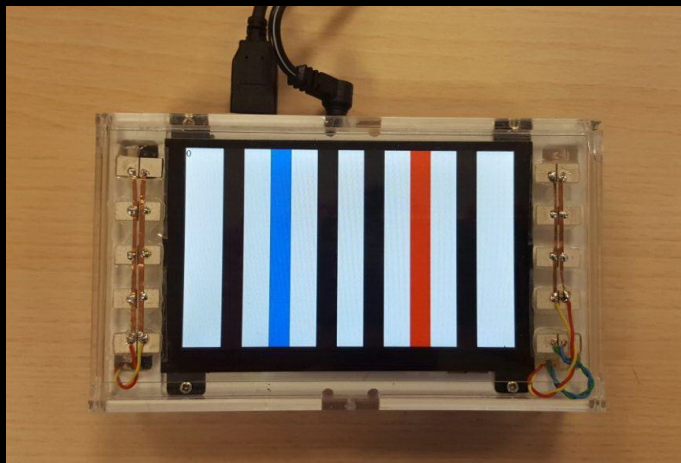
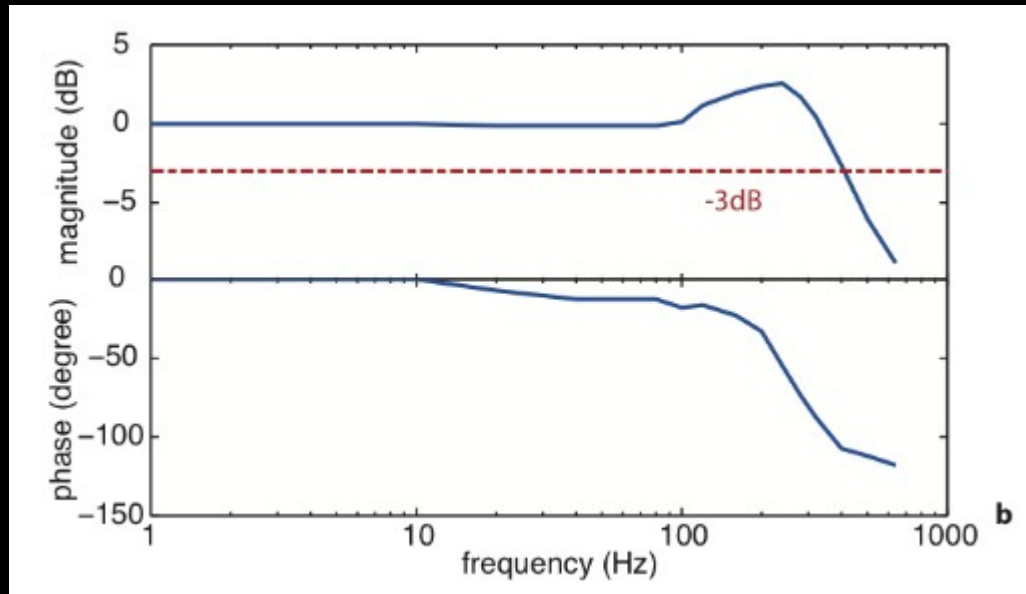
Ultrasonic Friction control



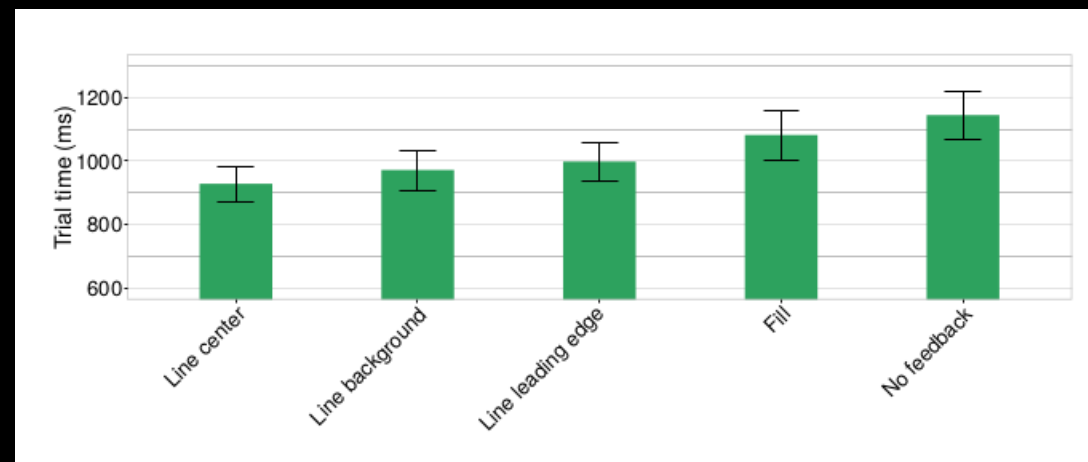
E. Vezzoli et al., "Friction Reduction through Ultrasonic Vibration Part 1: Modelling Intermittent Contact,"



Ultrasonic Friction control



Determining the haptic feedback position for optimizing the targeting performance on ultrasonic tactile displays
F Kalantari, E Lank, Y Rekik, L Grisoni, F Giraud - 2018

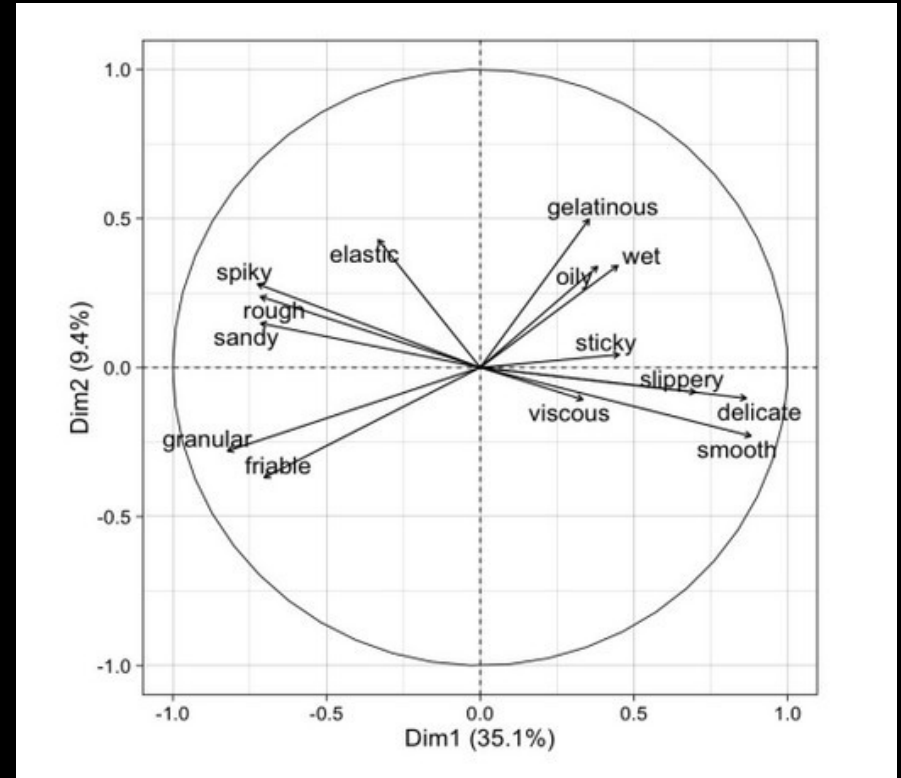


Time to complete the task

Ultrasonic Friction control

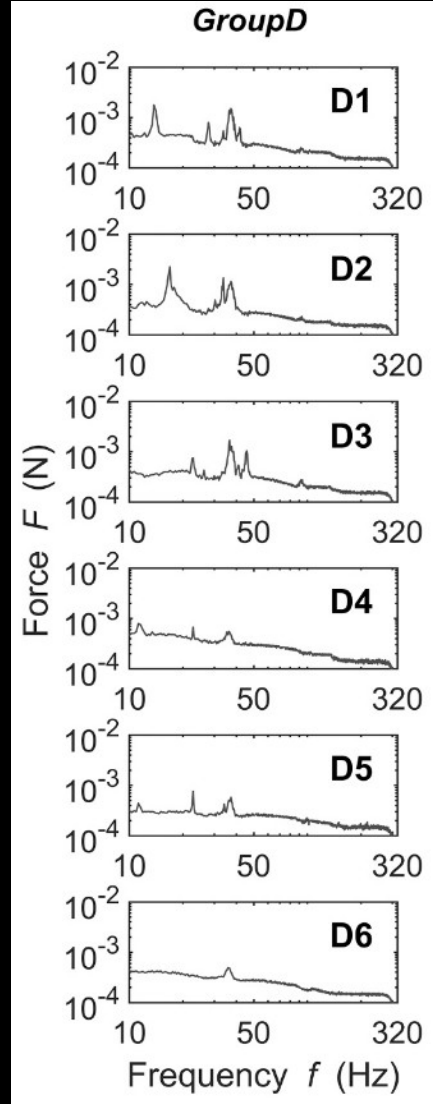
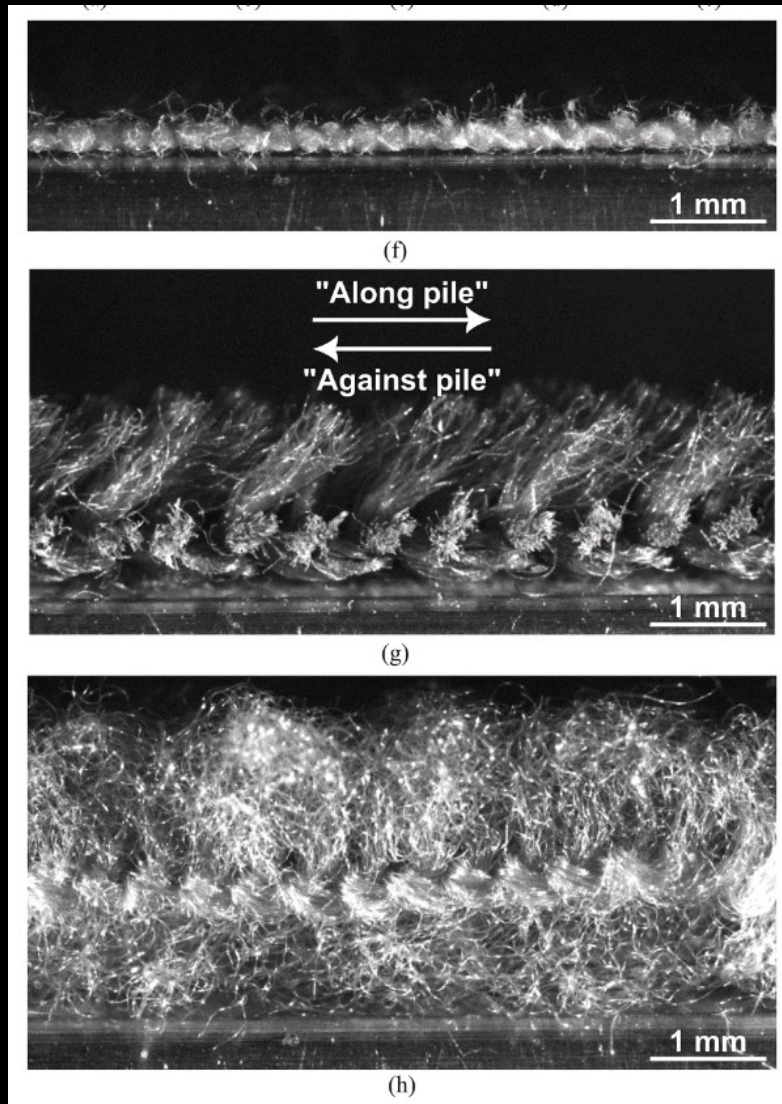


Investigating the semantic perceptual space of synthetic textures on an ultrasonic based haptic tablet M Dariosecq, P Plénacoste, F Berthaut, A Kaci, F Giraud HUCAPP 2020



Semantic Perceptual Space

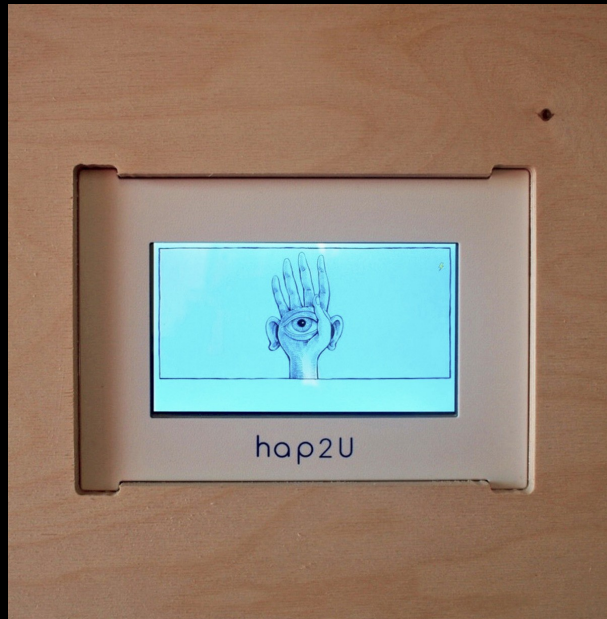
Ultrasonic Friction control



	<i>Rough</i>			<i>Smooth</i>		
	R1	R2	R4	R3	R5	R6
D1		47			53	
D2		69			31	
D4		58			42	
D3		59			41	
D5		19			81	
D6		31			69	

Tactile simulation of textile fabrics: Design of simulation signals with regard to fingerprint
B Weiland, F Leclinche, A Kaci, B Camillieri... - Tribology International, 2024

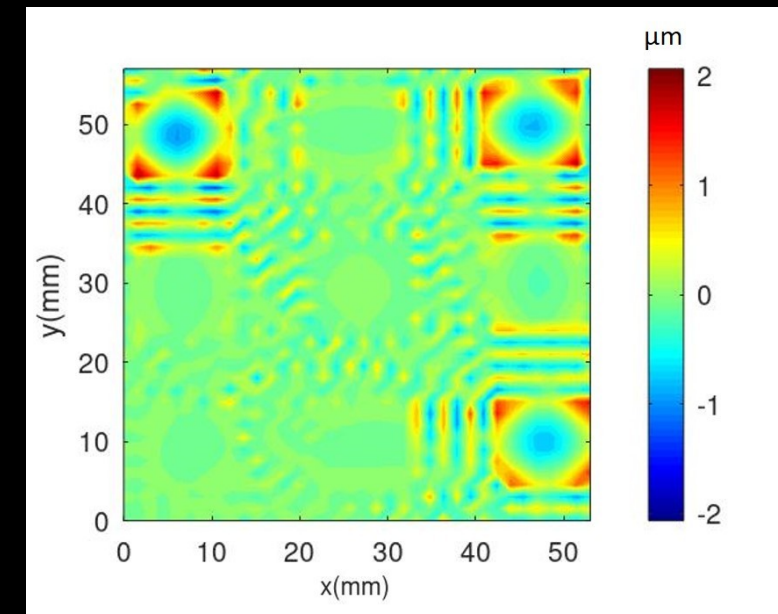
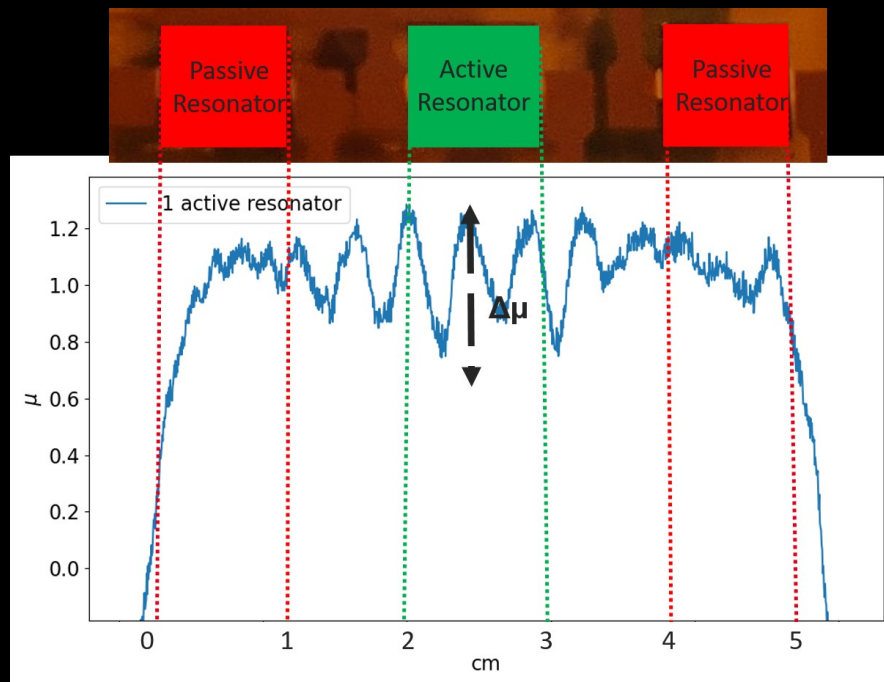
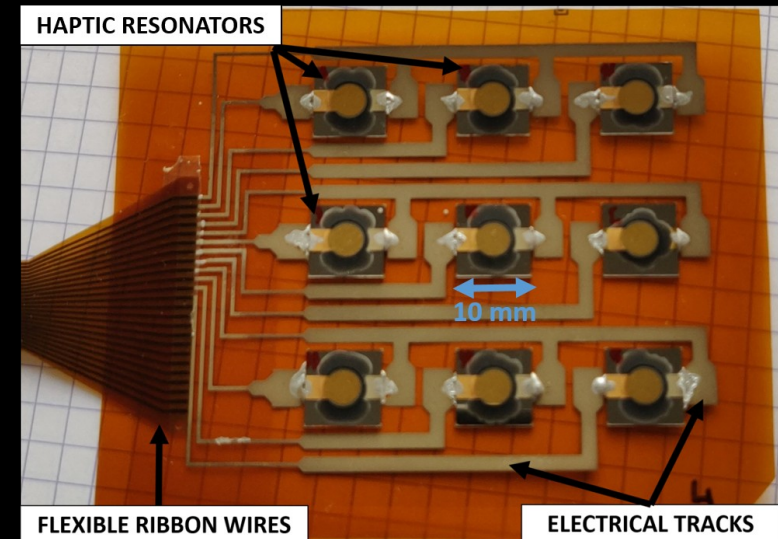
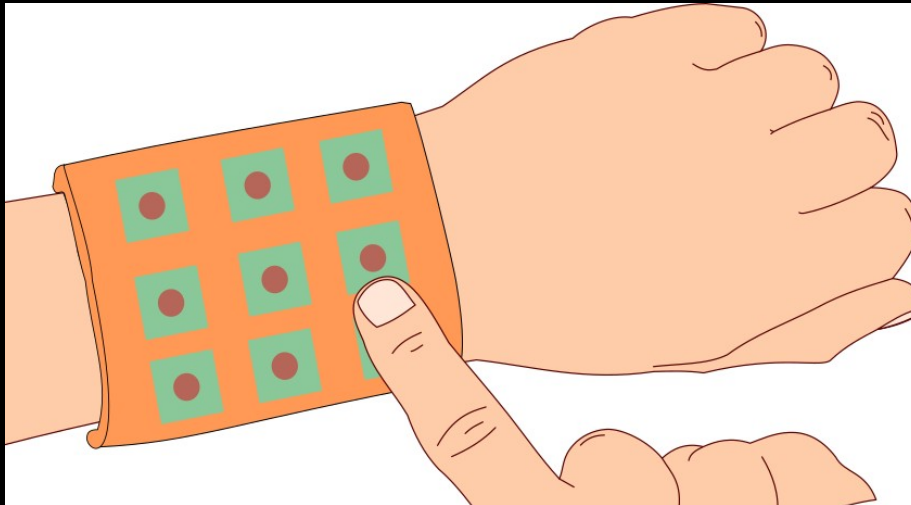
Ultrasonic Friction control



Princess Patouche (D. Maes 2015)

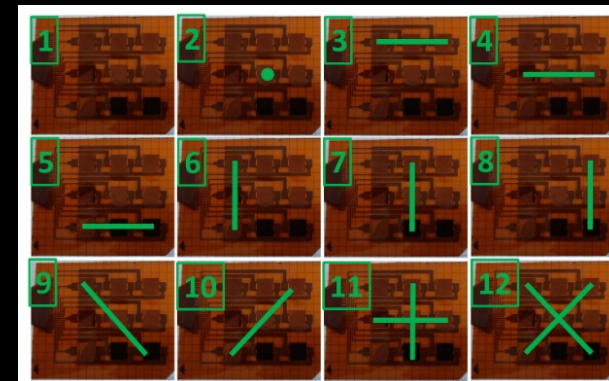
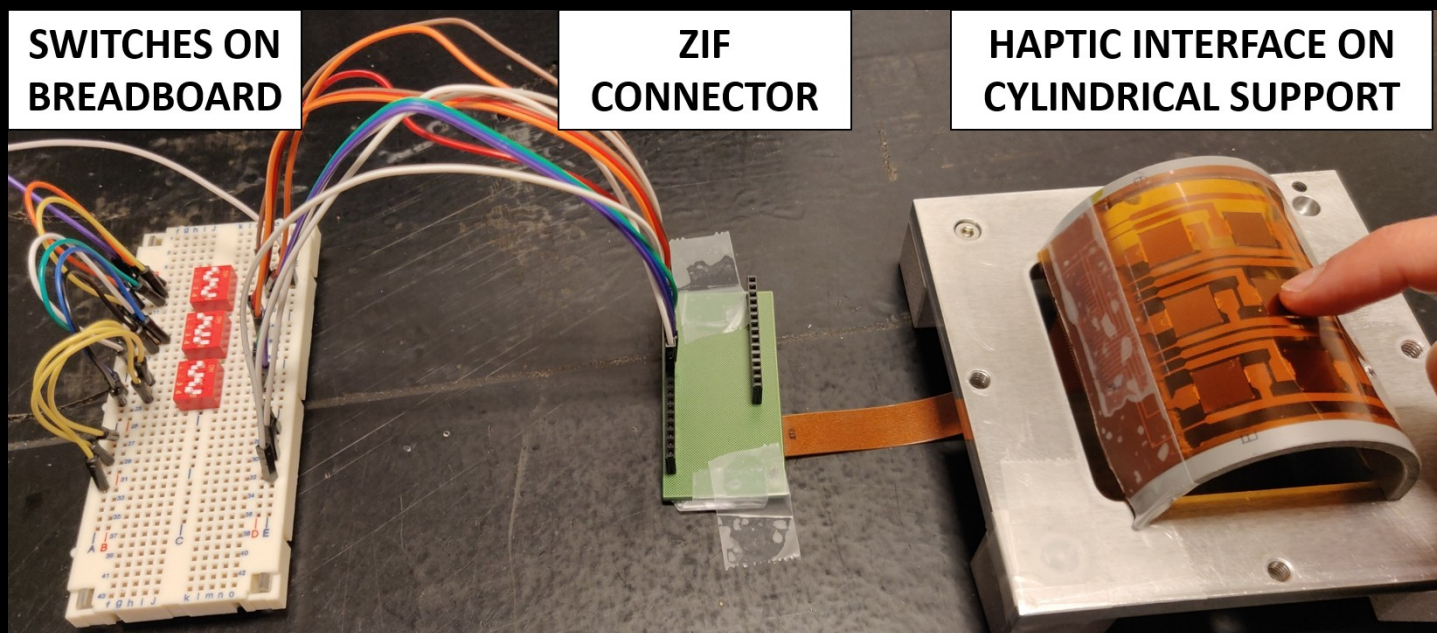


Ultrasonic Friction control : flexible interfaces



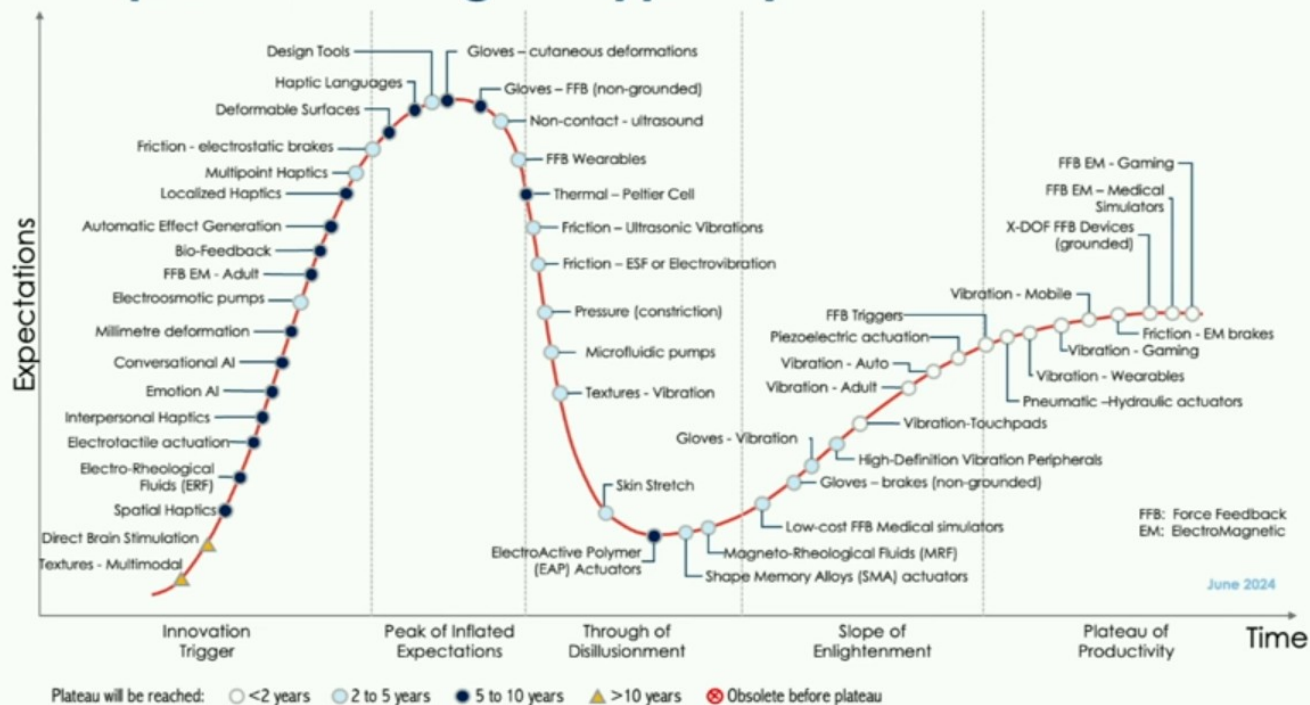
Reconfigurable flexible haptic interface using localized friction modulation R Le Magueresse, F Casset, F Giraud, MK Mendes... - IEEE Transactions on Haptics, 2025

Ultrasonic Friction control : flexible interfaces



		Perceived by users												Total played	Mean time for detection (s)
		1	2	3	4	5	6	7	8	9	10	11	12		
Played on the surface	1	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	48	12,8
	2	2,1	95,8	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	48	13,4
	3	2,8	0,0	94,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8	0,0	36	16,8
	4	0,0	4,2	0,0	91,7	0,0	0,0	0,0	0,0	0,0	0,0	4,2	0,0	48	16,3
	5	0,0	0,0	0,0	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	36	12,7
	6	0,0	0,0	0,0	0,0	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	36	11,3
	7	0,0	2,1	0,0	2,1	0,0	0,0	95,8	0,0	0,0	0,0	0,0	0,0	48	13,8
	8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100,0	0,0	0,0	0,0	0,0	36	10,9
	9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100,0	0,0	0,0	0,0	36	13,9
	10	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100,0	0,0	0,0	36	16,2
	11	0,0	0,0	0,0	2,8	0,0	0,0	5,6	0,0	0,0	0,0	91,7	0,0	36	13,9
	12	0,0	0,0	0,0	0,0	0,0	2,8	0,0	5,6	0,0	0,0	2,8	88,9	36	19,8
														480	14,3

Haptic Technologies Hype Cycle



<https://webtv.univ-lille.fr/grp/716/eurohaptics-2024/>