

talking directly to the body: the user's muscles as input & output device by using electrical muscle stimulation

pedro lopes // human computer interaction lab // sketching in hardware

# motivation

[why is immersion not yet mobile?]



...graphics were the first key to immersion



...and then came **motion sensors**

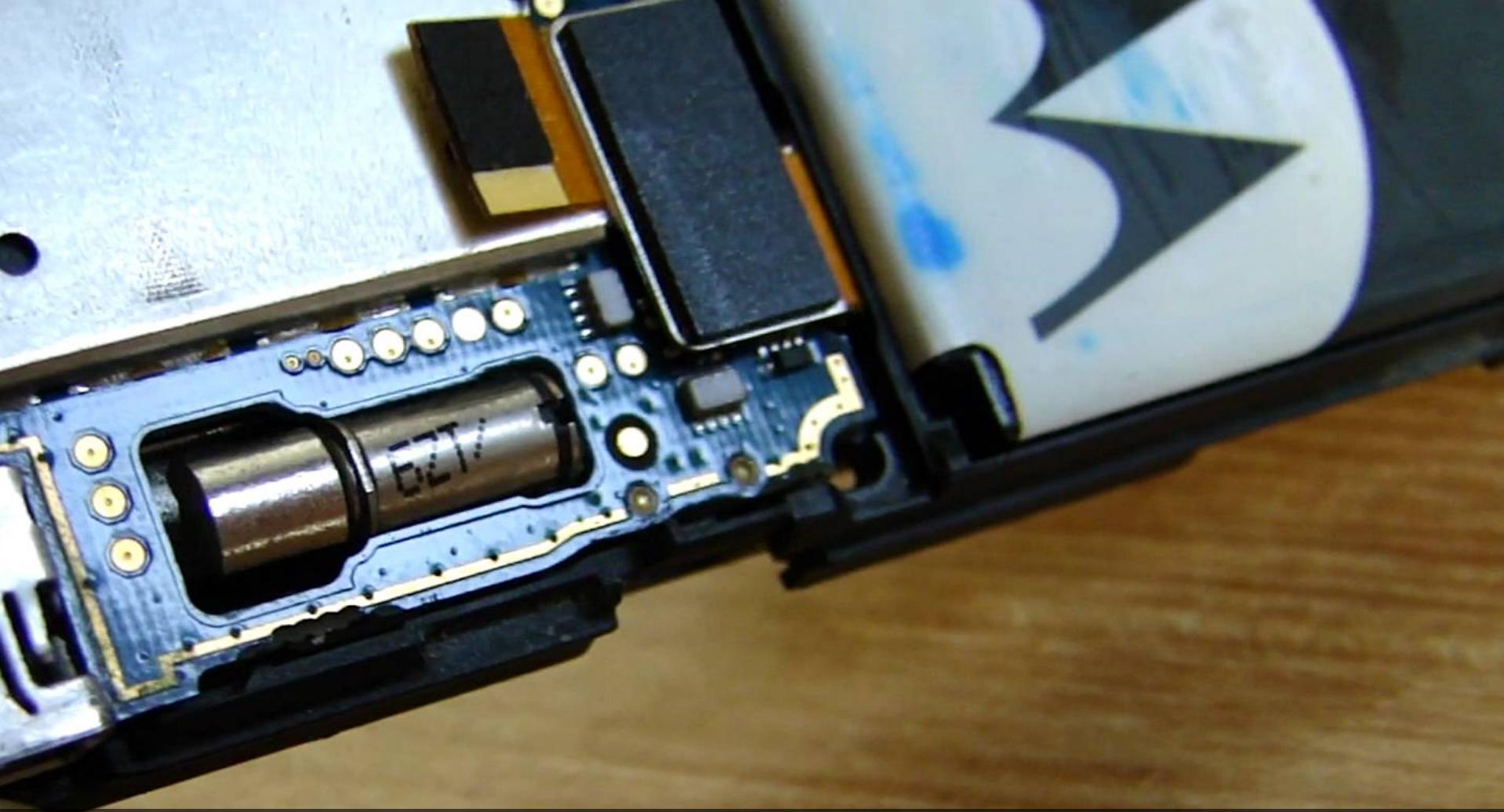


now researchers say:  
**haptics is the next step towards realism!**

[ali israr]



...haptics on mobile devices are **weak**



such as vibration, small actuators, etc...

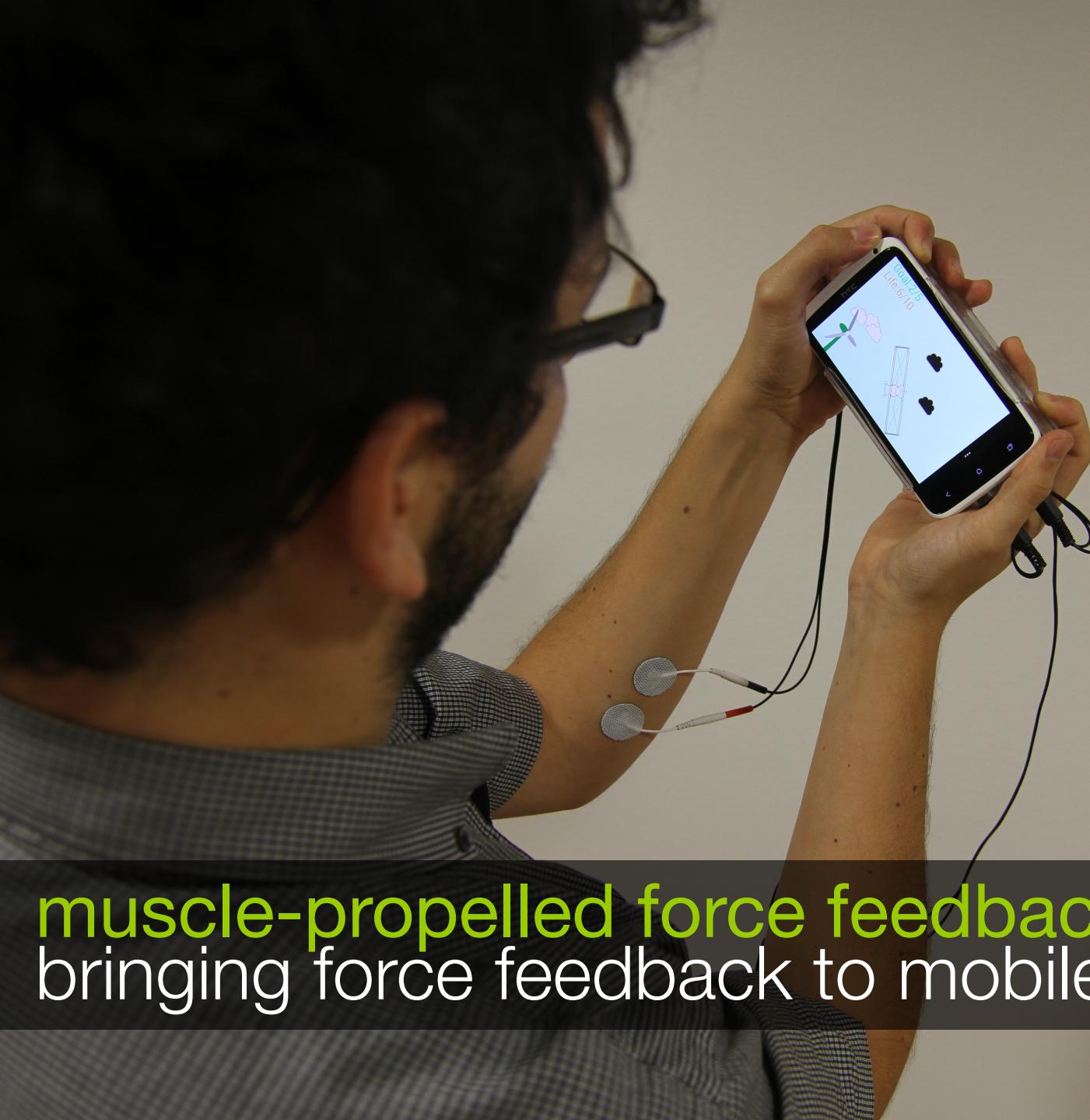


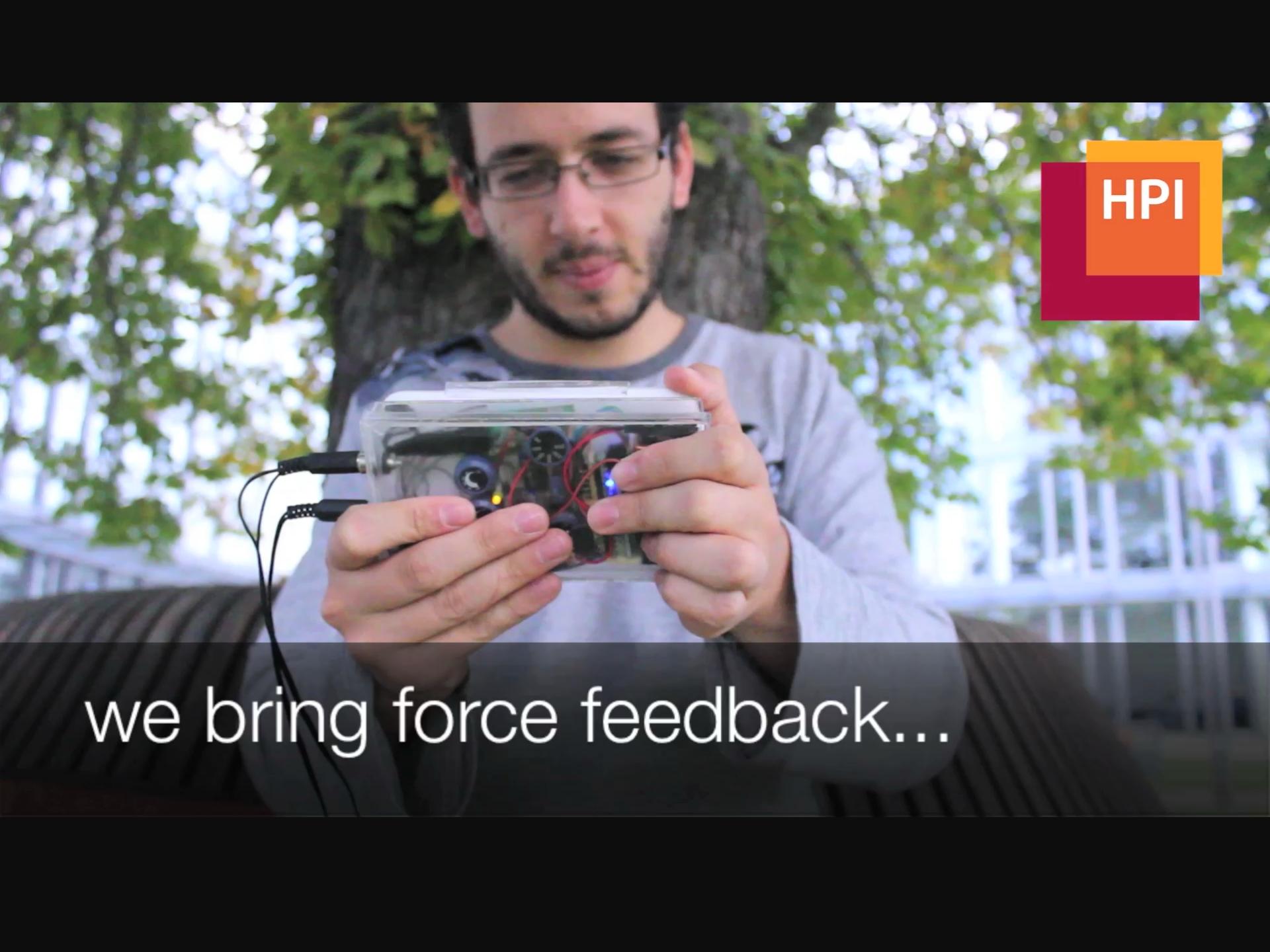
for large actuation and mobility  
researchers focused on exoskeletons  
but these are **heavy** and get in the way

so that's the challenge we tackle  
provide sense of **realistic forces**,  
through substantially **smaller hardware**

chi'13

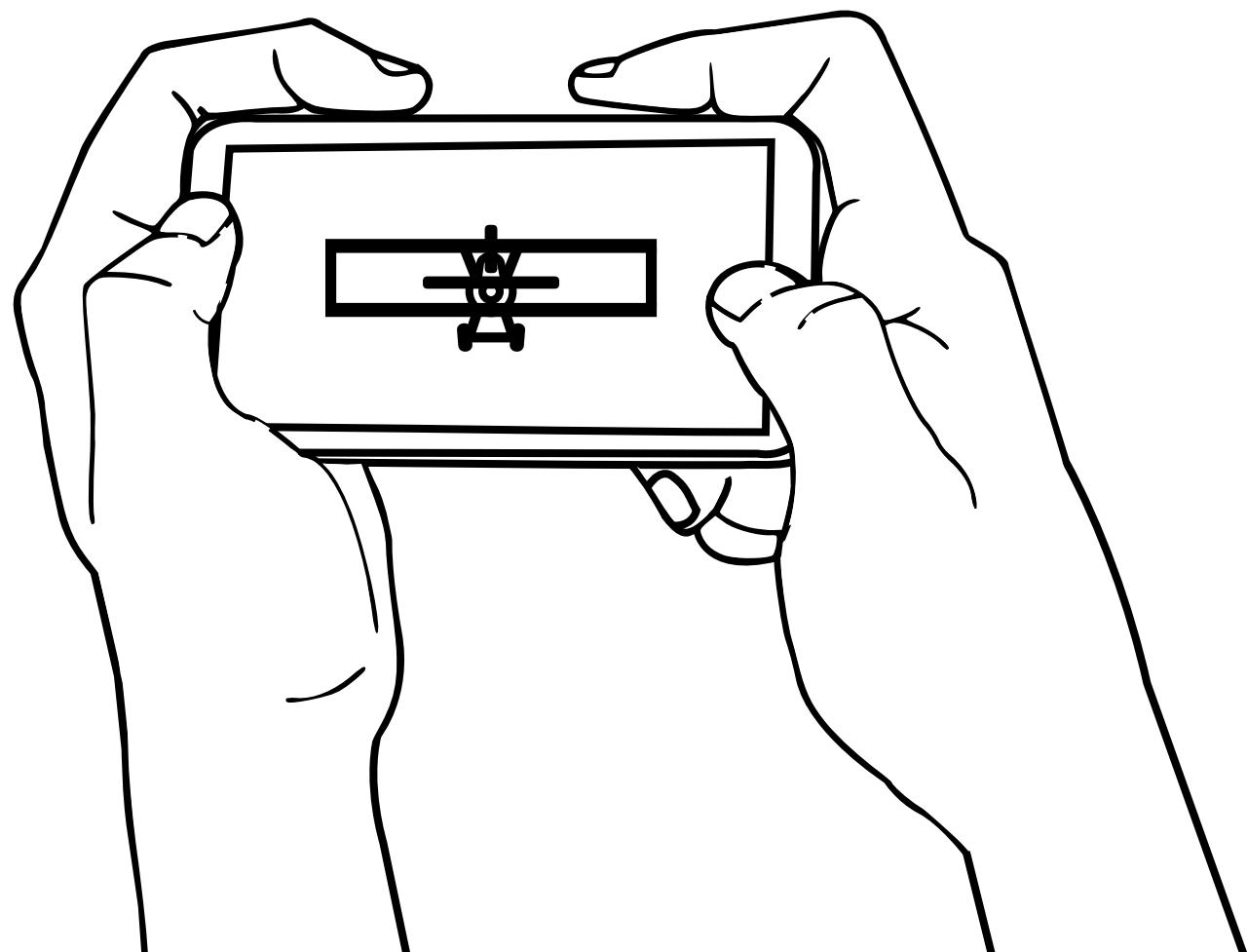
# **muscle-propelled force feedback** bringing force feedback to mobile devices



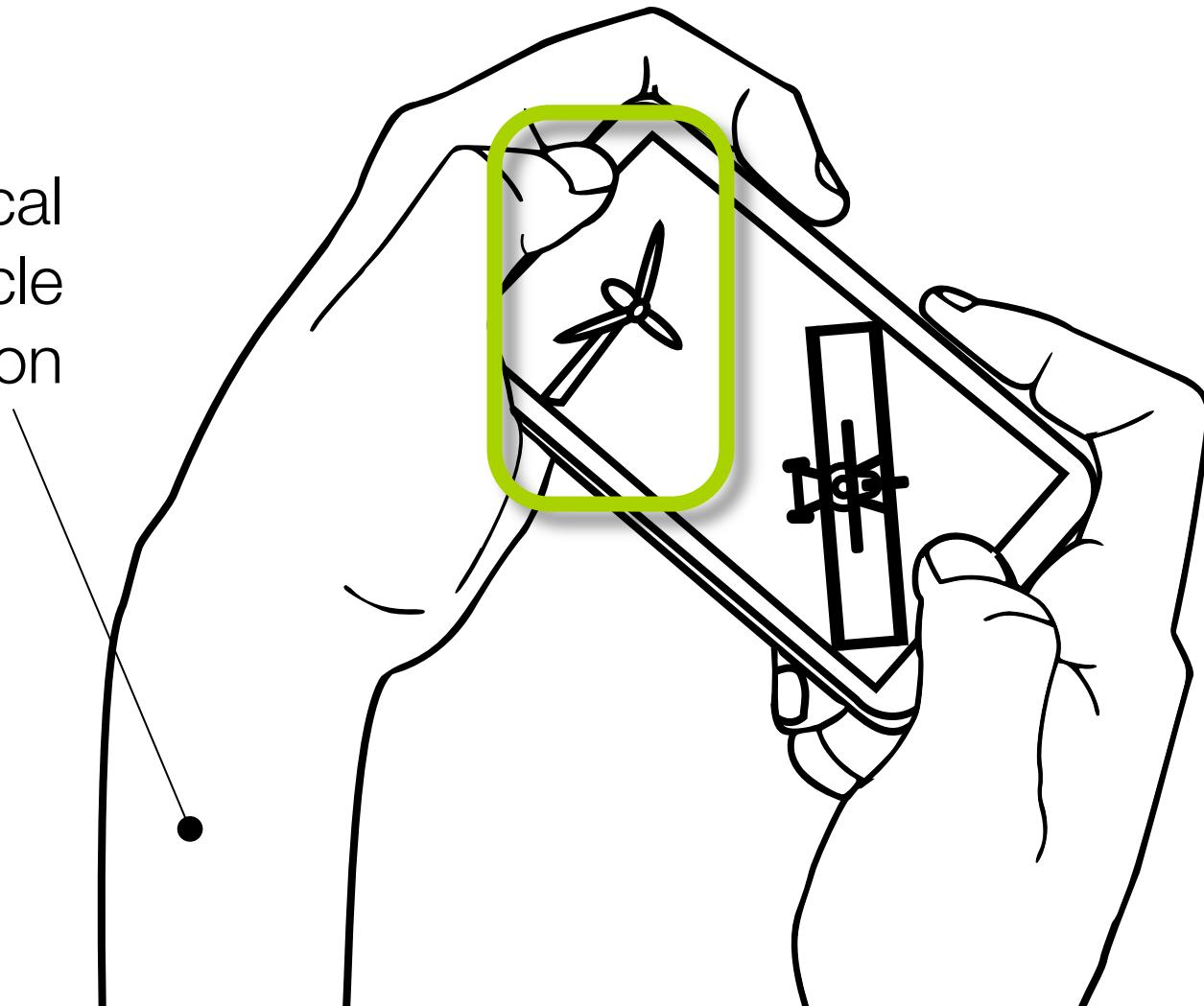
A close-up photograph of a man with dark hair, a beard, and glasses, wearing a grey sweatshirt. He is holding a transparent plastic case containing a small mechanical or electronic device with visible internal parts like gears and wires. A black cable with a connector is attached to the device. In the background, there are green trees and a white fence. In the top right corner of the image, there is a logo consisting of two overlapping squares: a red one on the bottom and an orange one on top, with the letters "HPI" written in white.

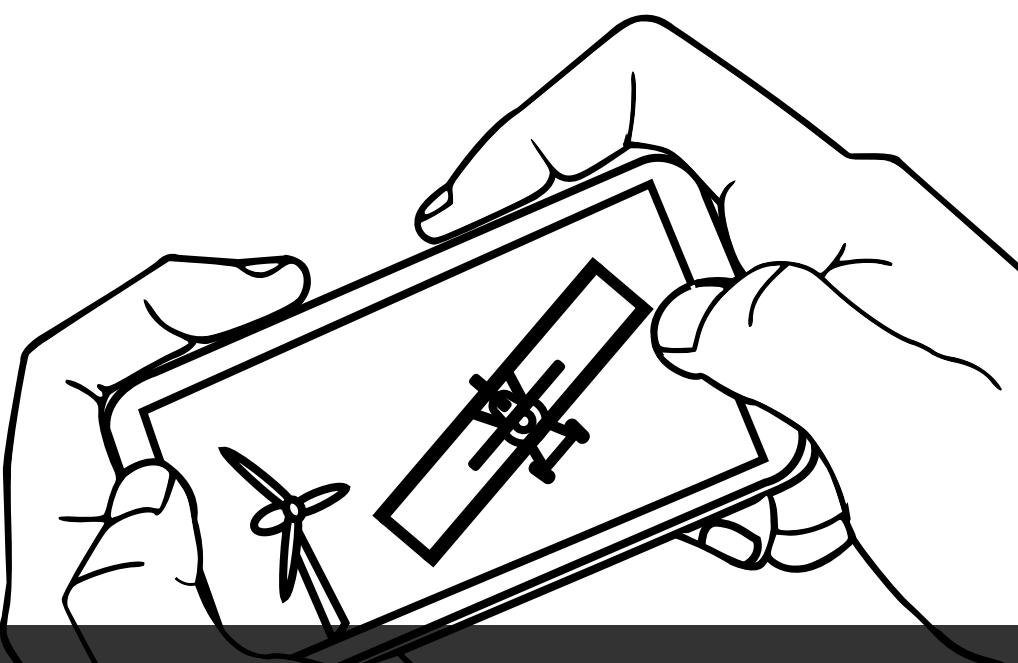
HPI

we bring force feedback...



electrical  
muscle  
stimulation



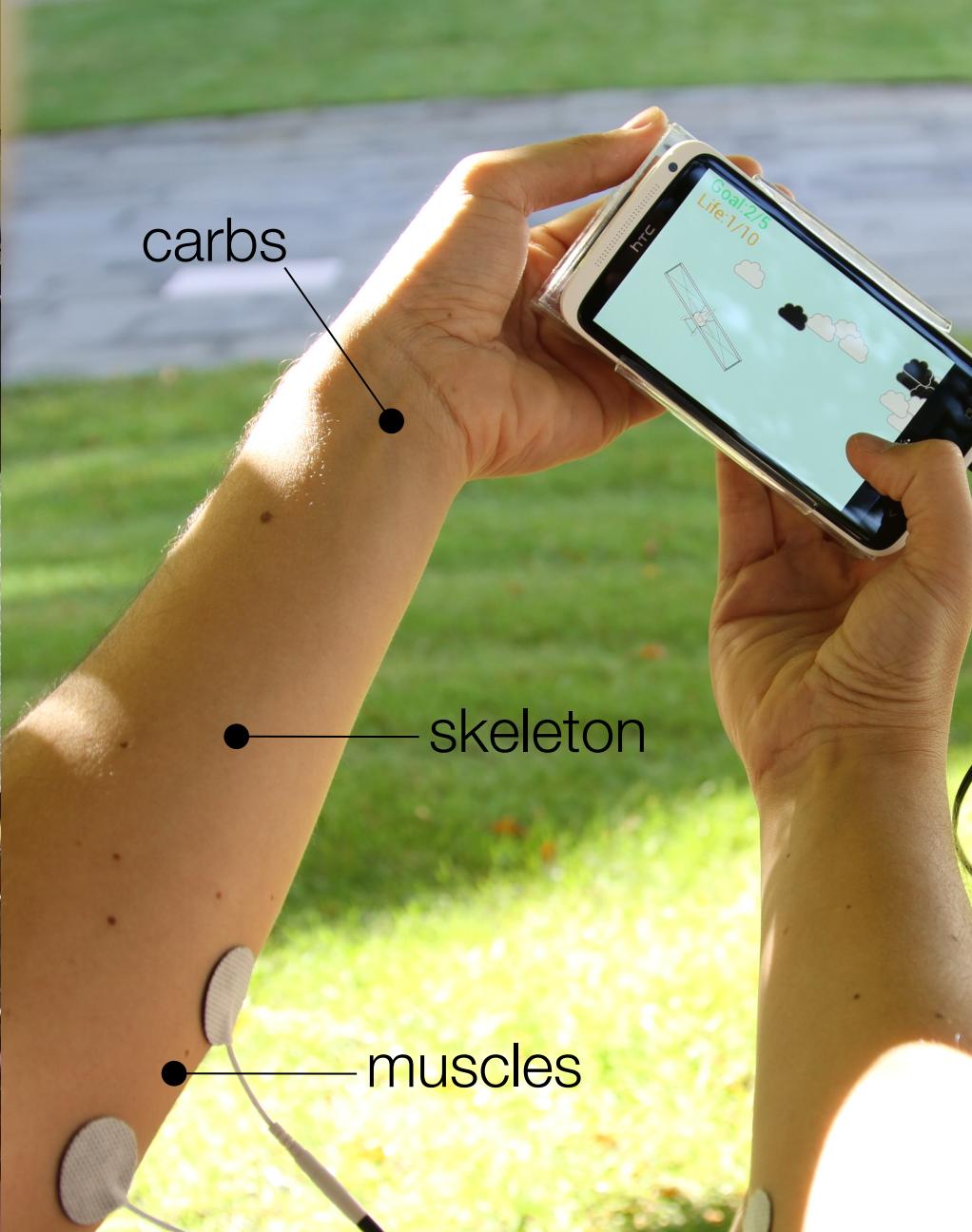


user  
counteracts  
and resists

... the user **perceives force feedback**



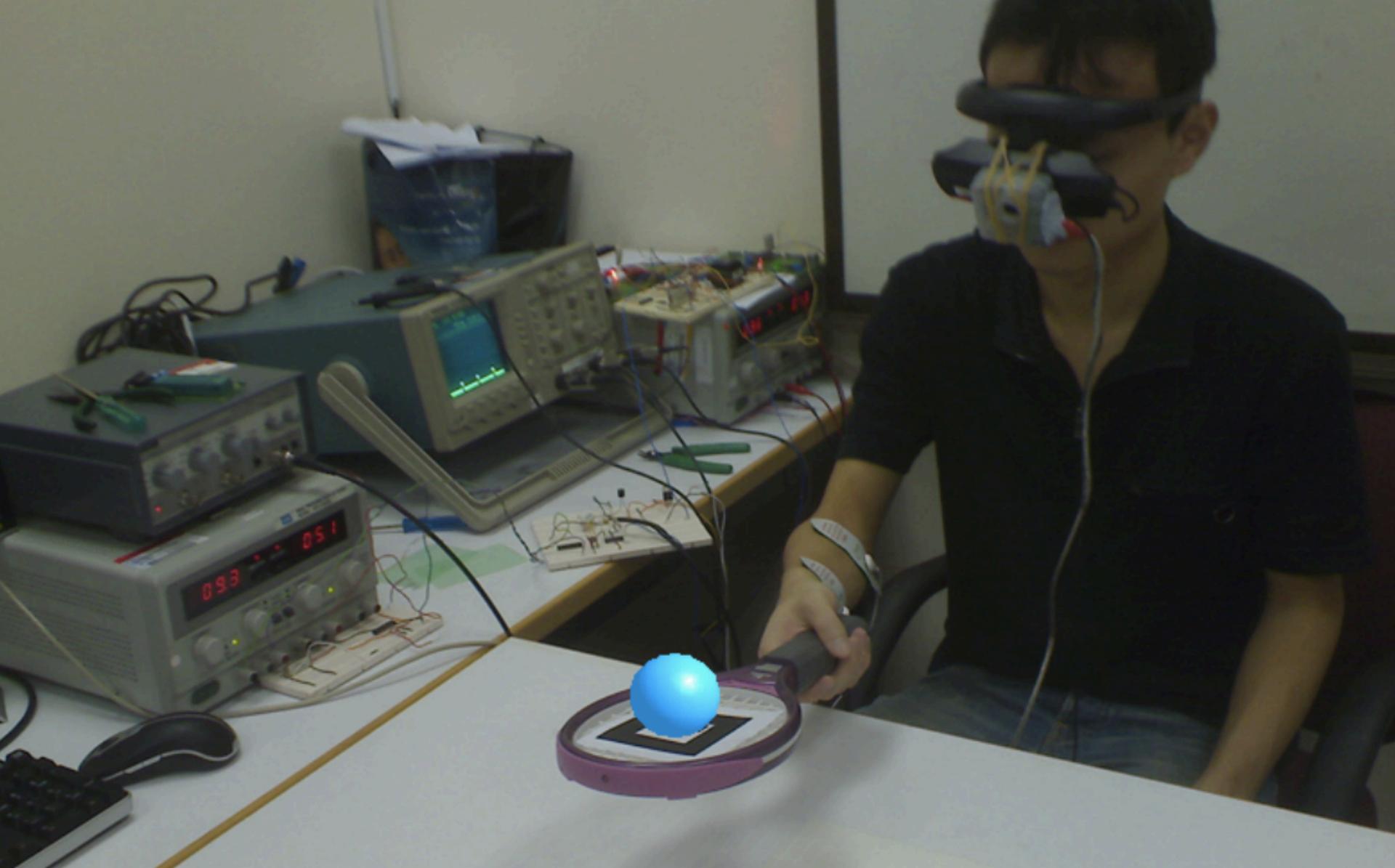
... device has no **motors or actuators**



contribution:: mobile force feedback

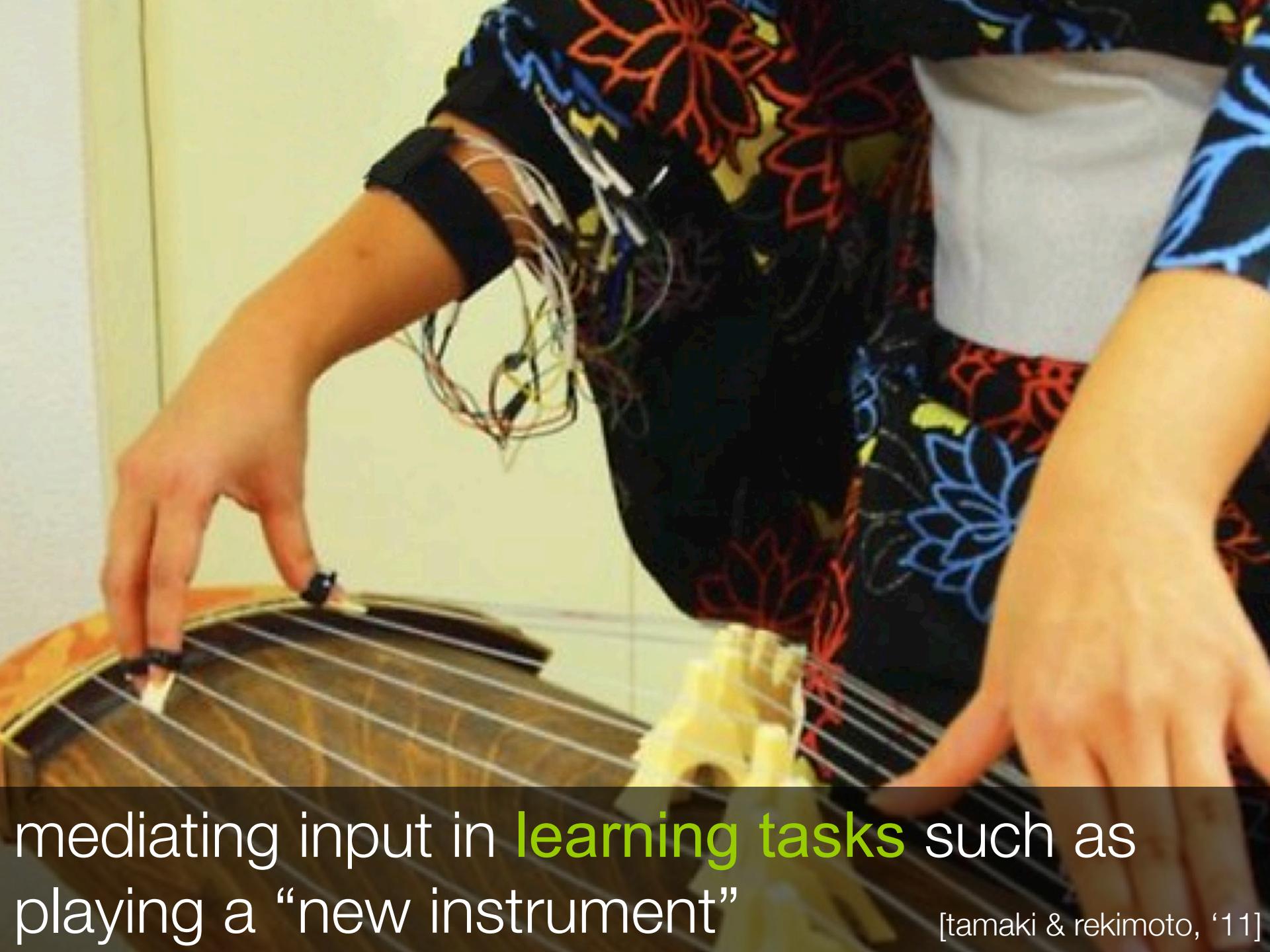


rehabilitation, since the 60's



augmented tennis **with** muscle stimulation

[farbiz et. al, '07]



mediating input in **learning tasks** such as  
playing a “new instrument”

[tamaki & rekimoto, '11]



experience:: mobile force-feedback



android phone  
w/ accelerometers

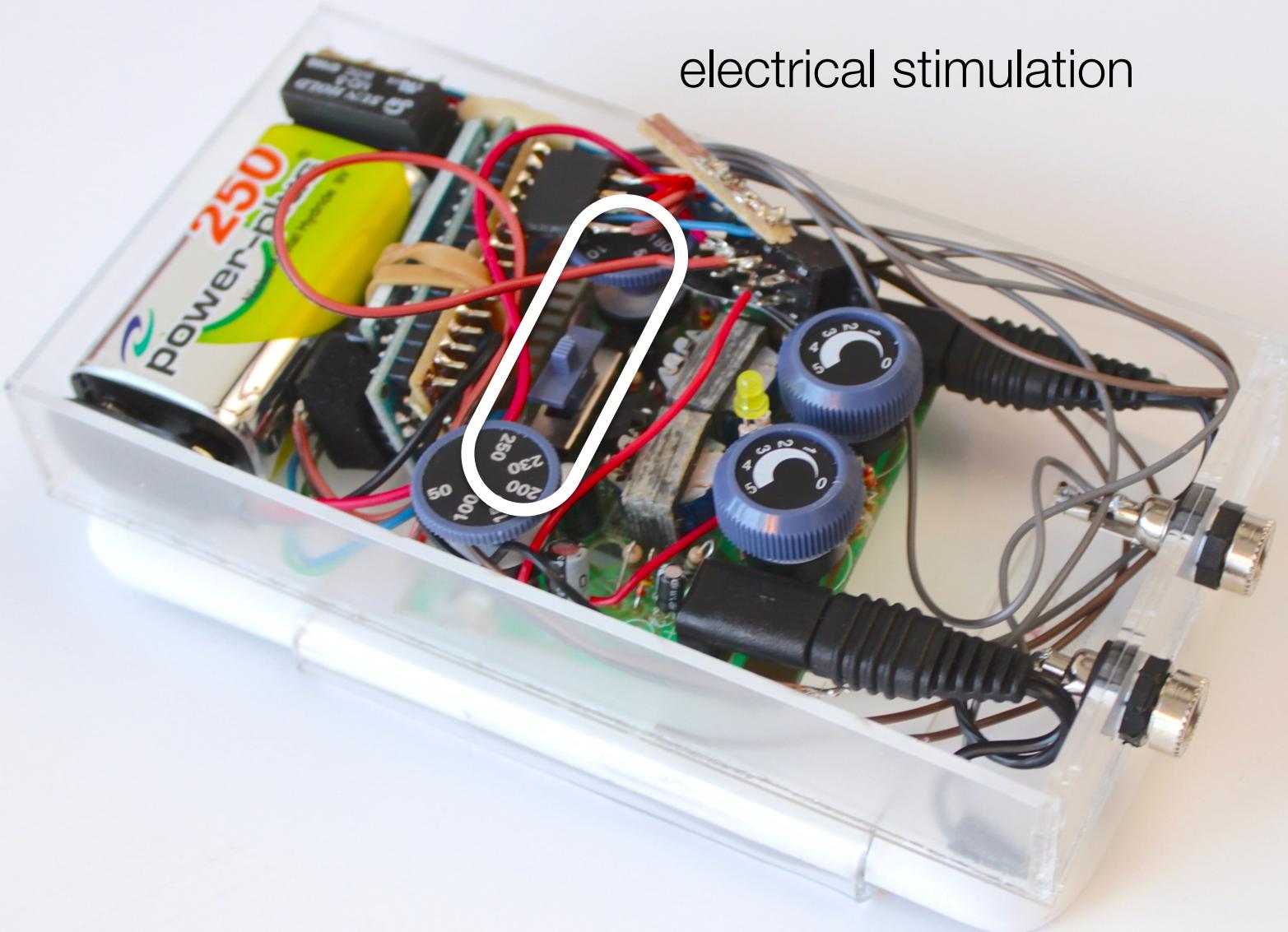
bluetooth



a tiny computer



electrical stimulation



medical compliant  
amplifiers (50v/100mA)

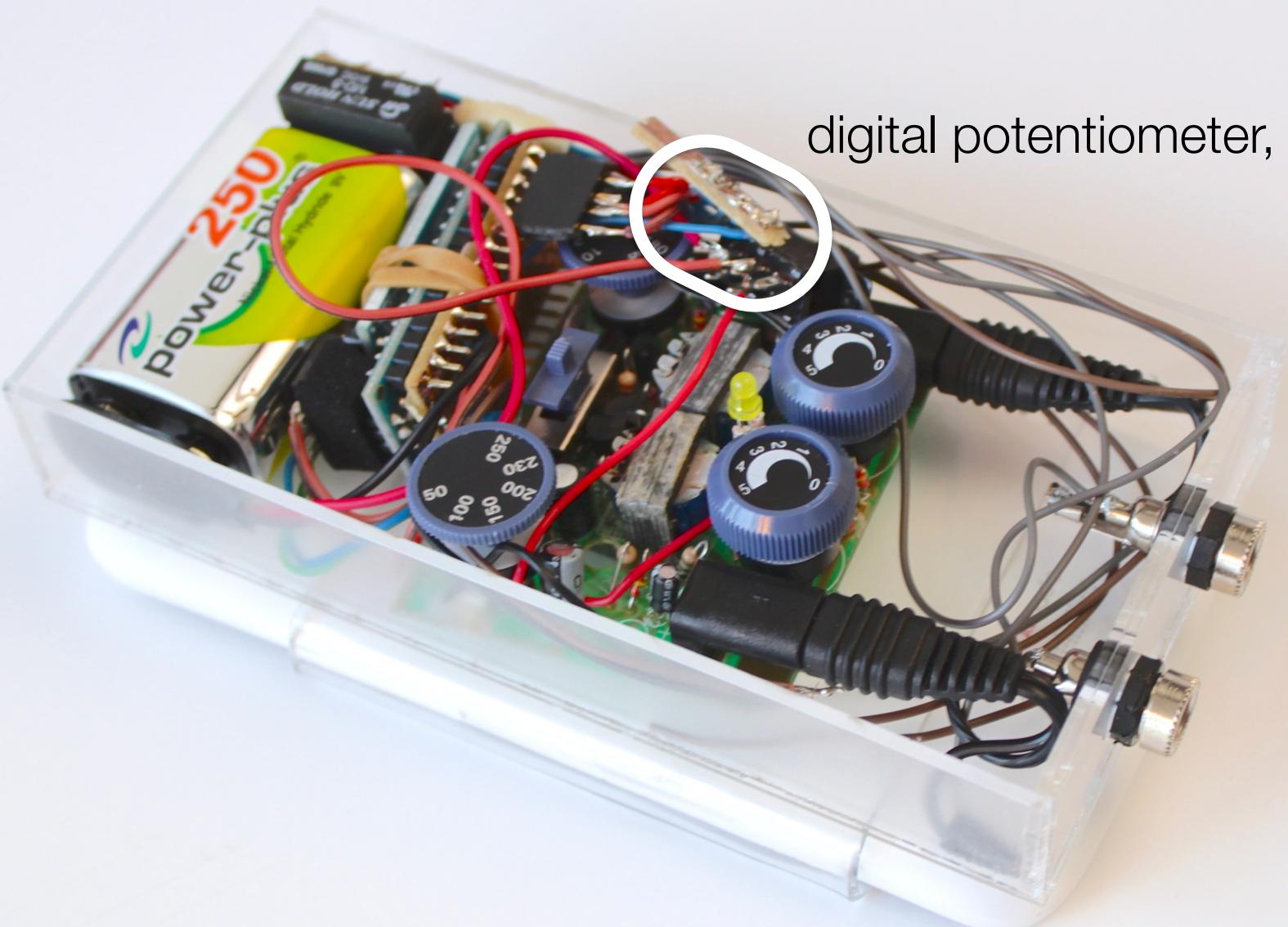


# hack #1: “old school” style

relays, unmodified circuitry

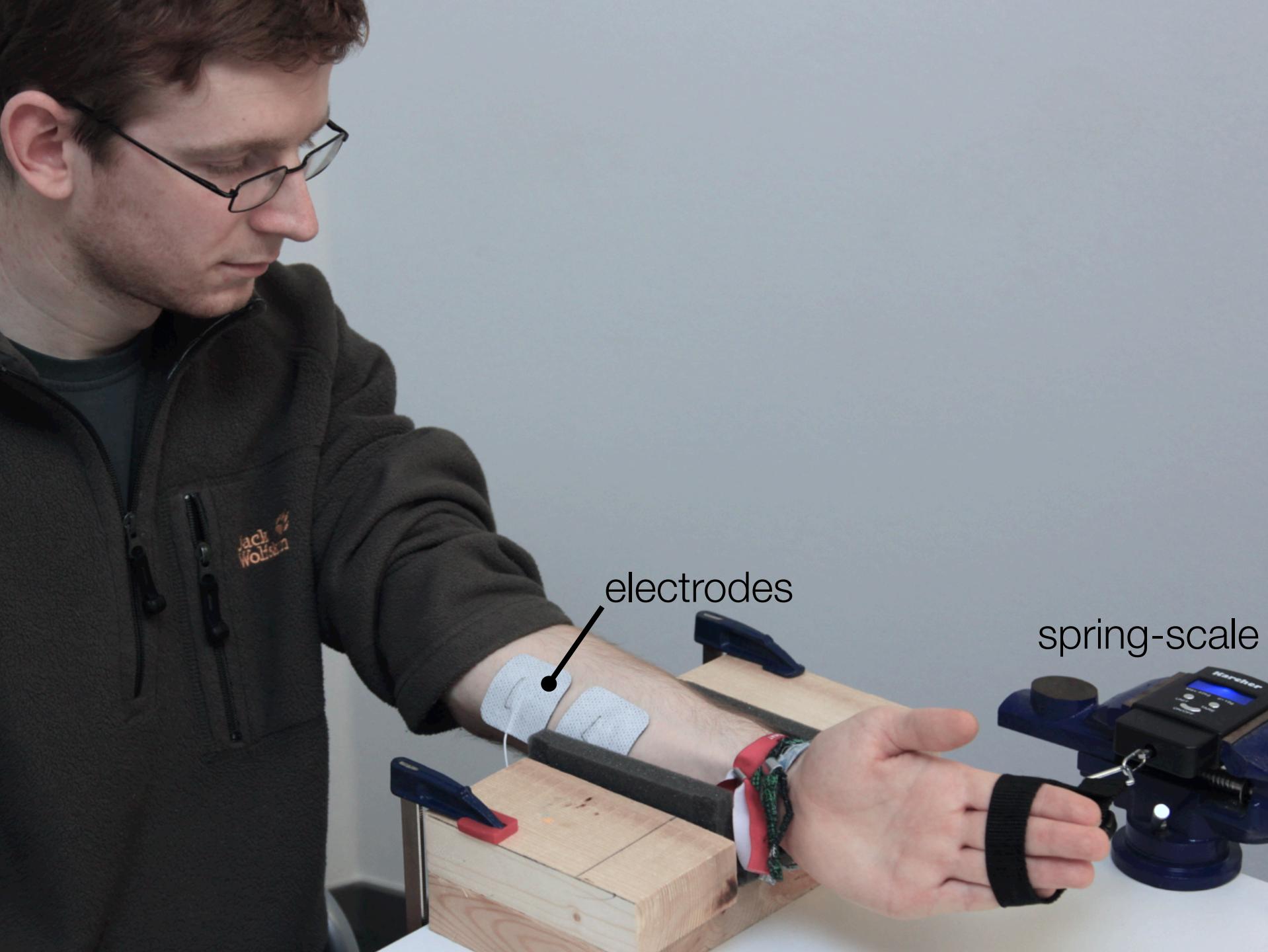


## hack #2: “proxy” style

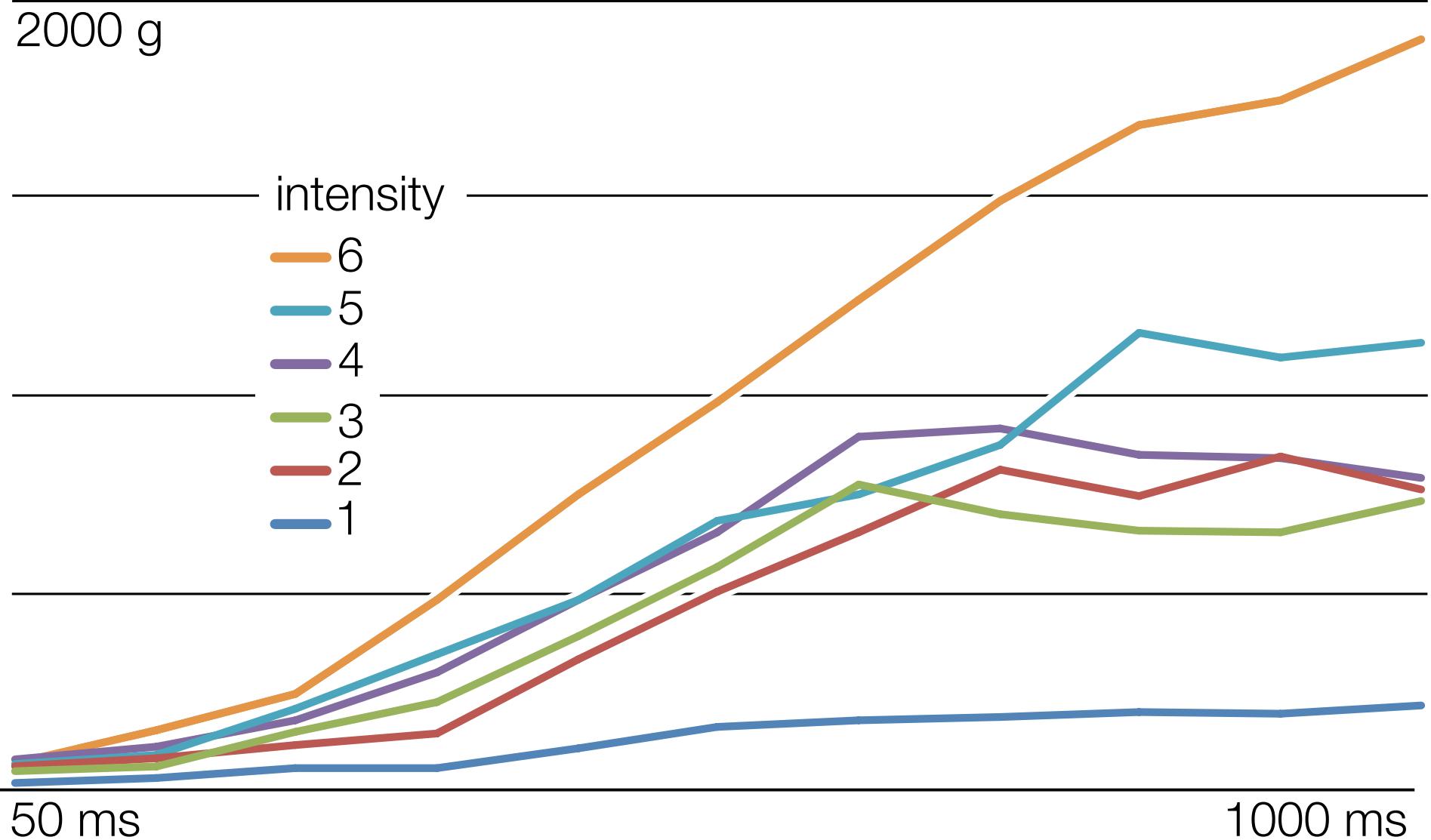


**how much force** can it really generate?  
(i.e., could you lift a water bottle?)

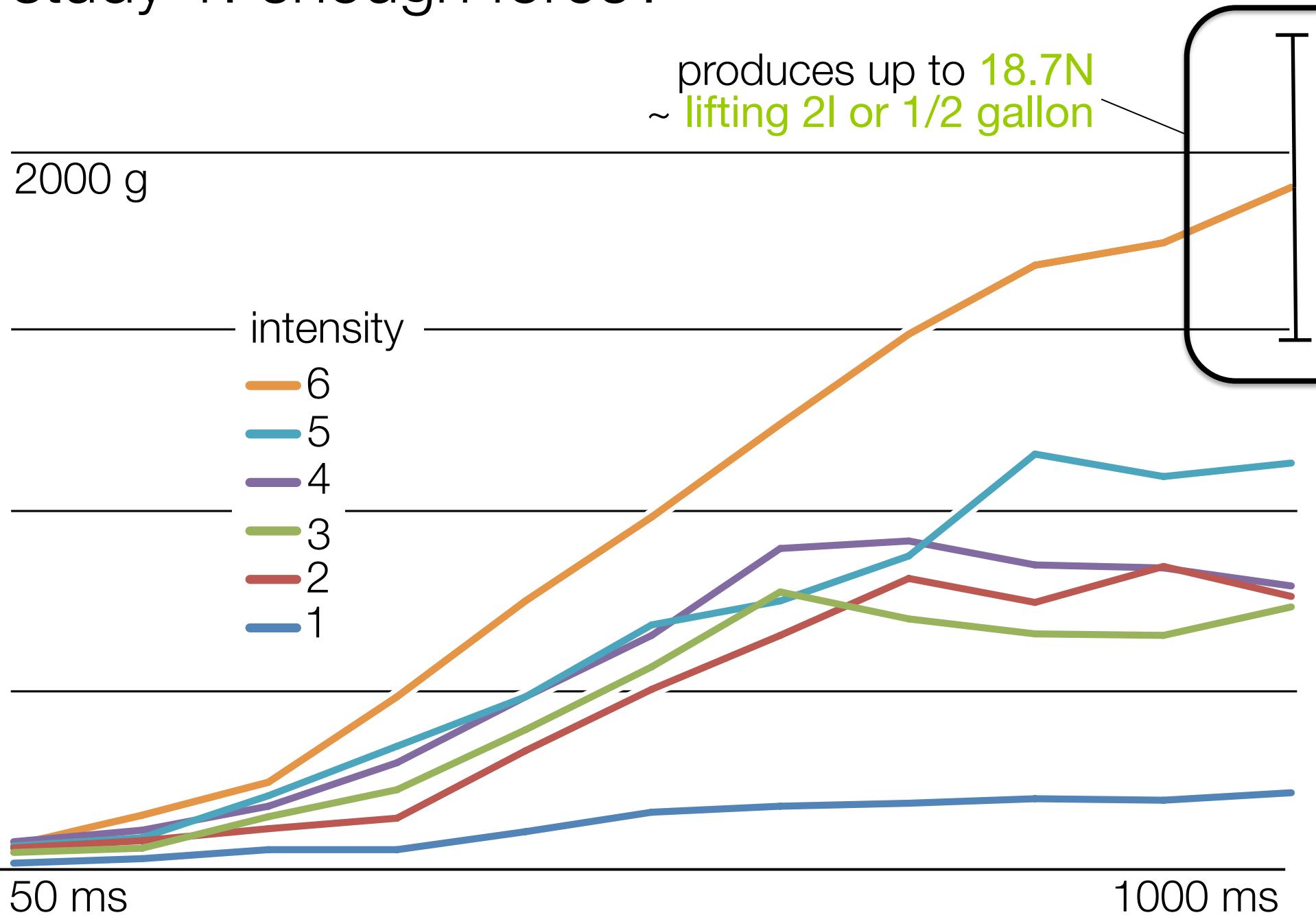




# study 1: enough force?



# study 1: enough force?





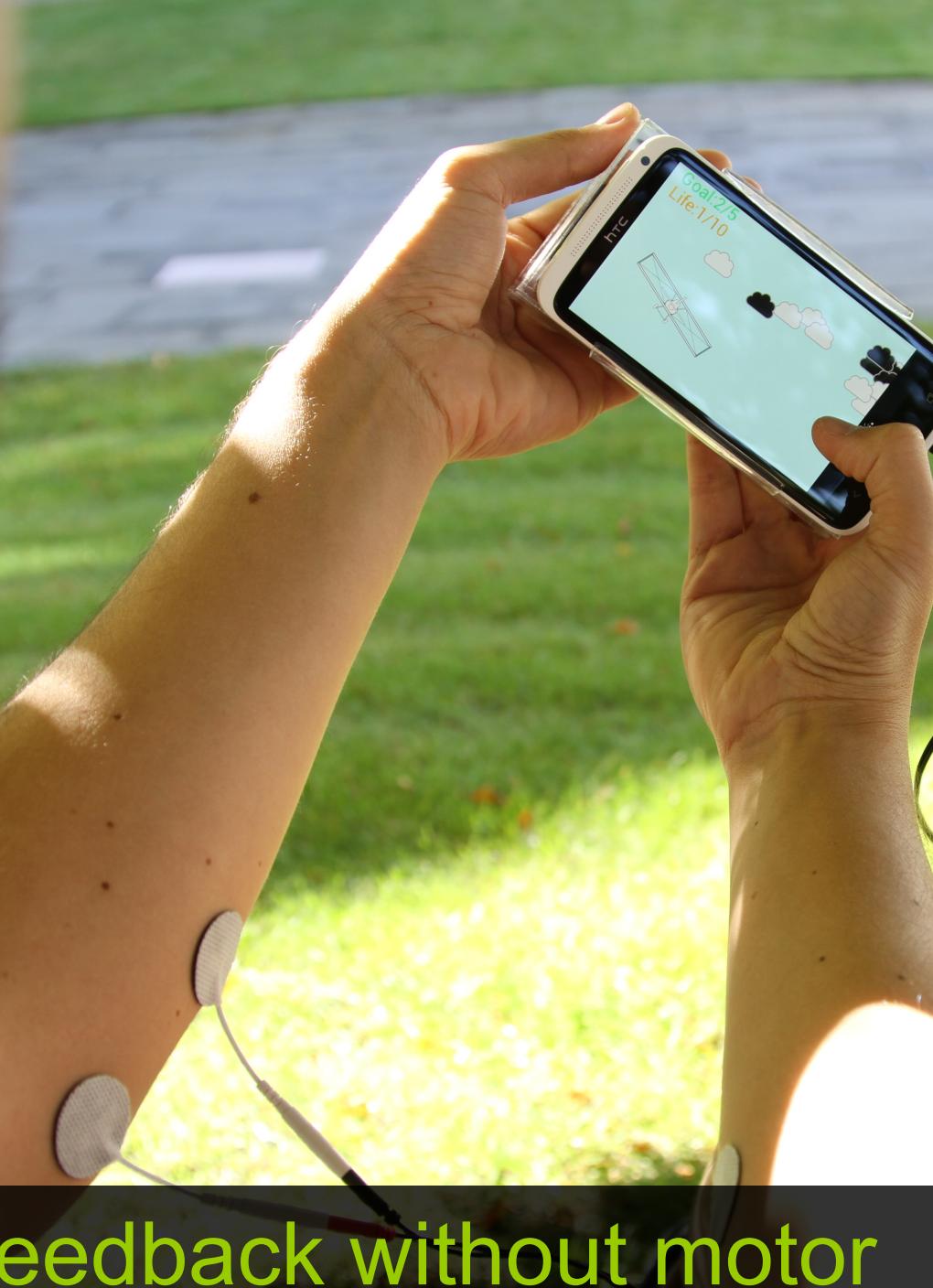
remarkable user reactions and excitement

muscle-propelled interfaces are substantially smaller than mechanical actuators, about the size of a phone..

we started wondering: could we make it smaller?

# conclusions

[wearables that talk directly to the body]



contribution:: force feedback without motor

# acknowledgements

[for all those who helped me]



thanks,  
questions?