ME 327: Design and Control of Haptic Systems
Spring 2020

Lecture 2:
Tactile and Kinesthetic Devices

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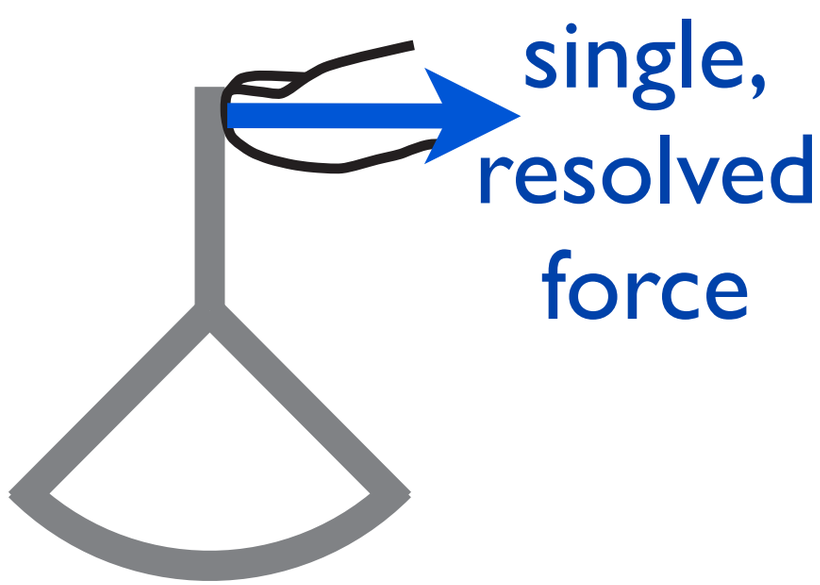
today's objectives

explain the fundamentals of kinesthetic and tactile devices

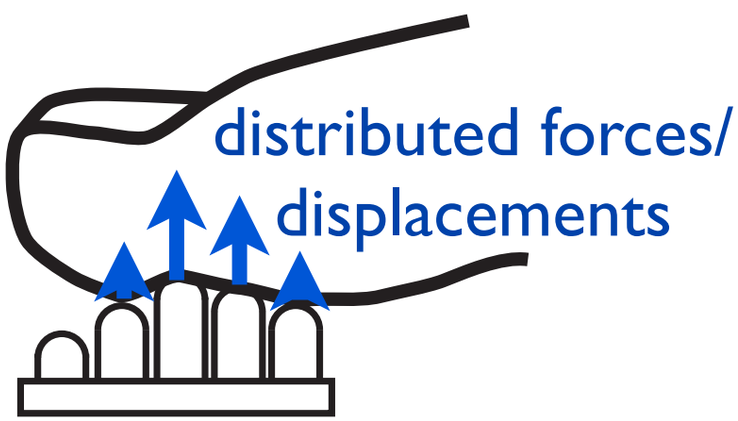
consider what haptic devices are good for

kinesthetic vs. tactile haptic devices

Kinesthetic haptic devices display forces or motions through a tool

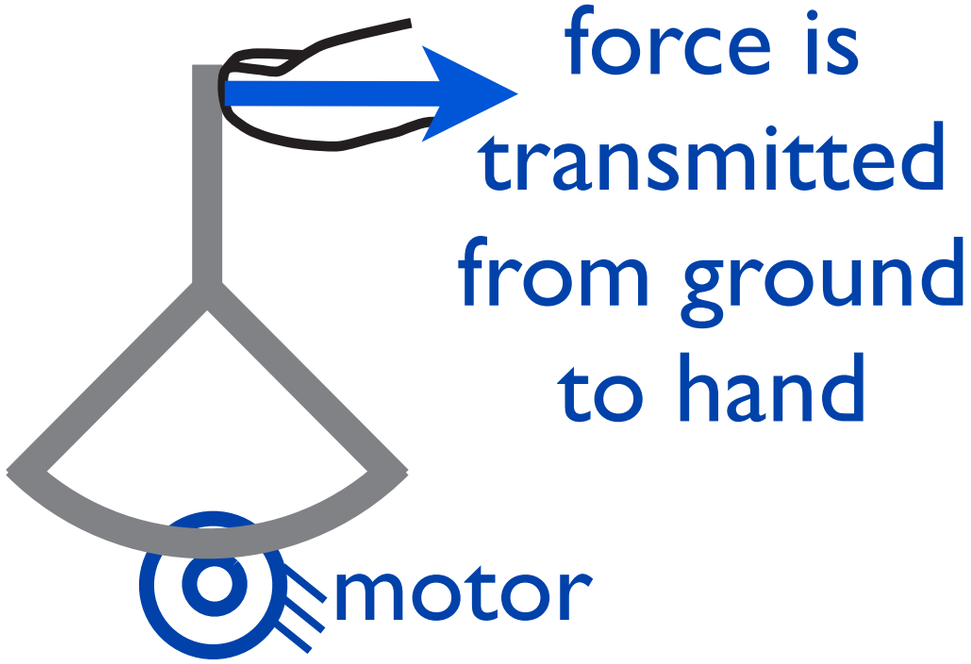


Tactile haptic devices stimulate the skin

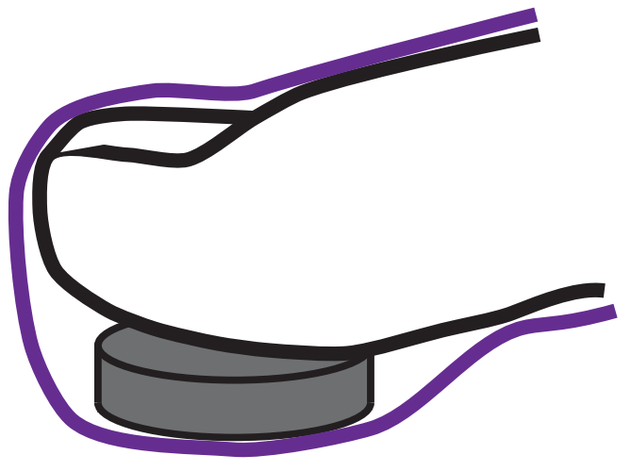


kinesthetic vs. tactile haptic devices

Kinesthetic haptic devices are usually **grounded**



Tactile haptic devices can more easily be **wearable**



vibration feedback element encased in glove

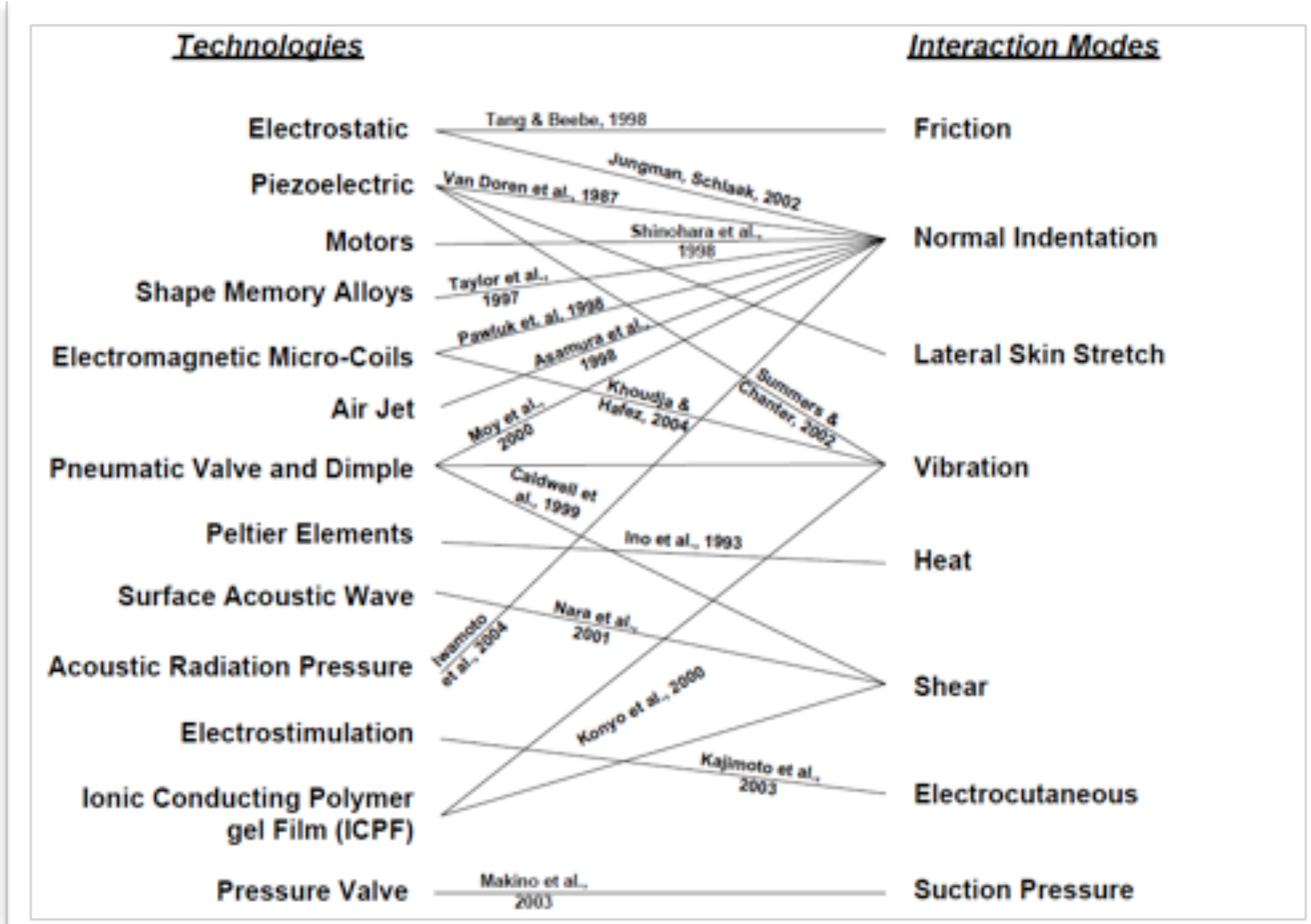
tactile (cutaneous) device basics

tactile feedback

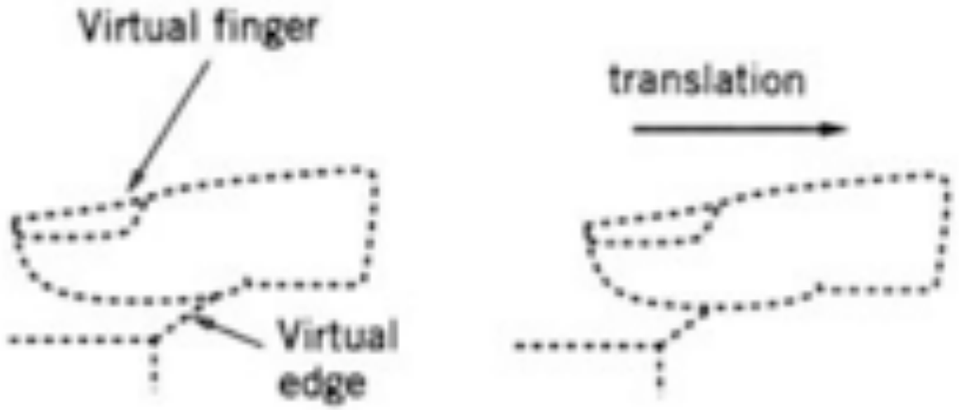
- goal is to stimulate the **skin** in a programmable manner to create a desired set of sensations
- *sometimes* **distributed** tactile feedback is provided
- tactile feedback is generated by a **tactile device**, sometimes called a **tactile display**
- not usually called a **tactile interface**

  why not?
- can aim to recreate real sensations, create novel ones, or communicate information

technologies and interaction modes

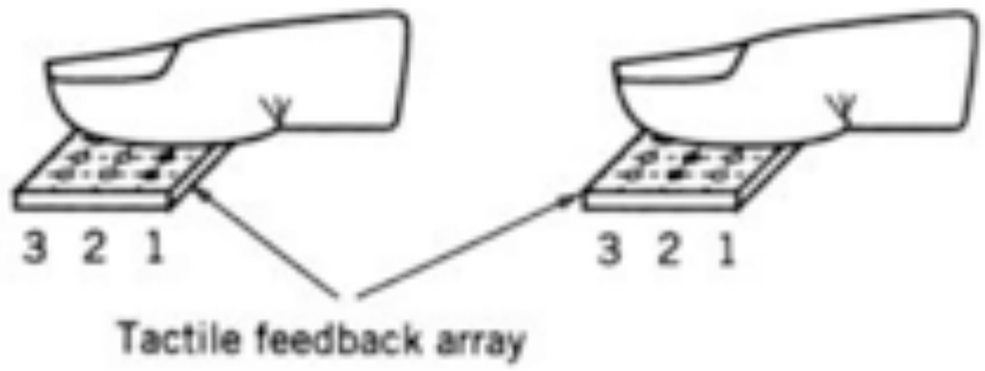


Jerome Pasquero, Survey on Communication through Touch, Technical Report: TR-CIM 06.04, 2006

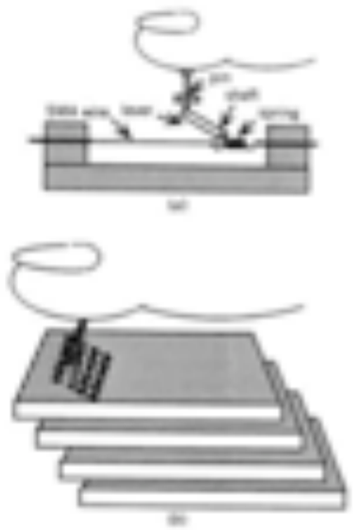


Burdea & Coiffet (1994)

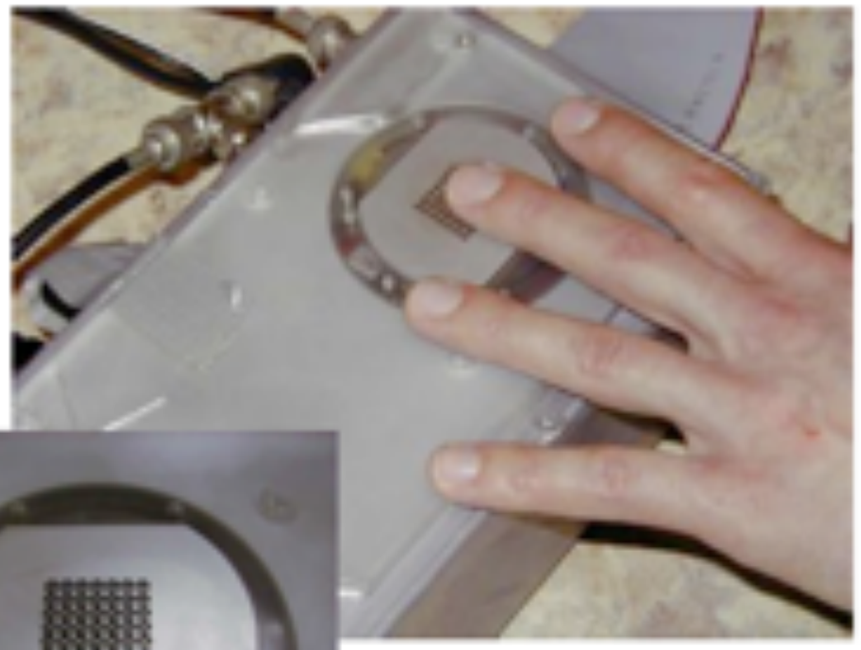
Wagner & Howe (2002)

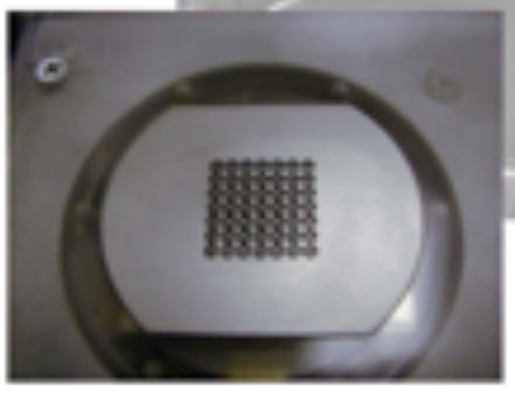


Tactile feedback array



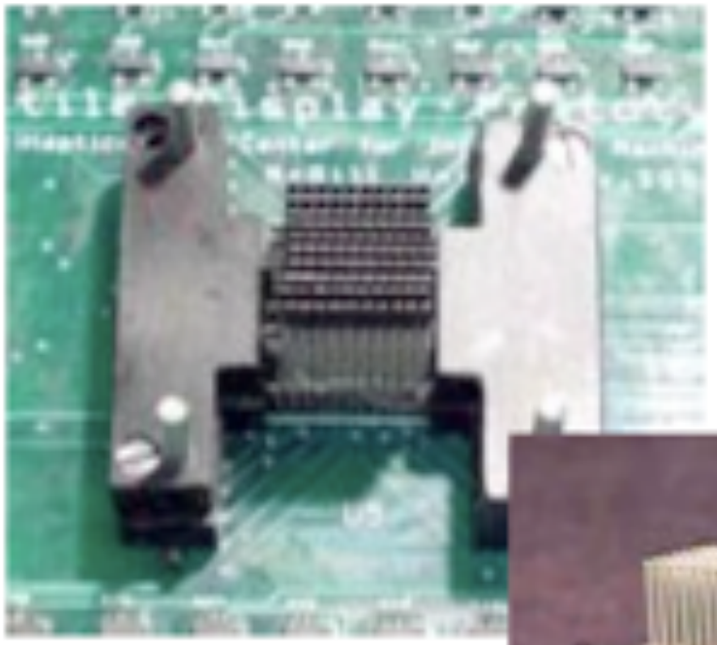
Kontarinis, et al. (1995)





Kaczmarek, et al. (1995)

Russell

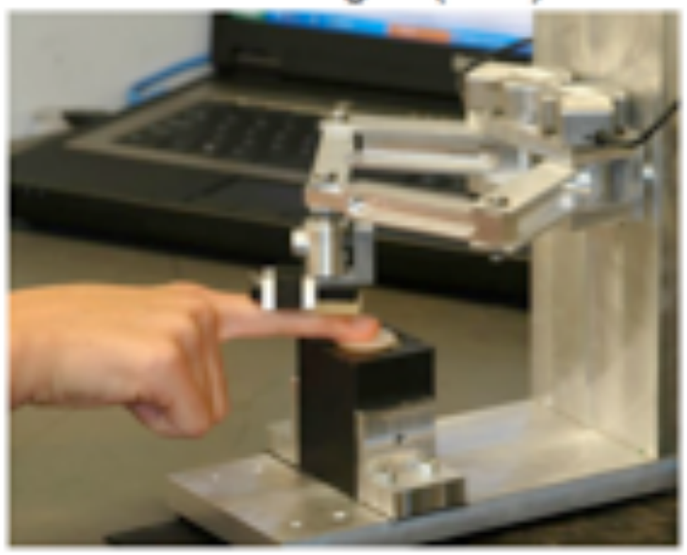


Hayward, et al. (2003-7)

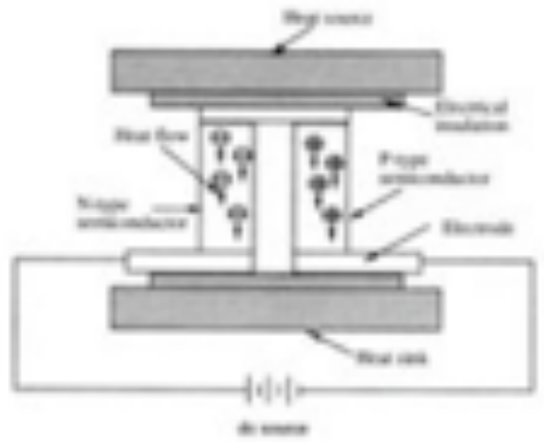
Glassmire thesis (2006)

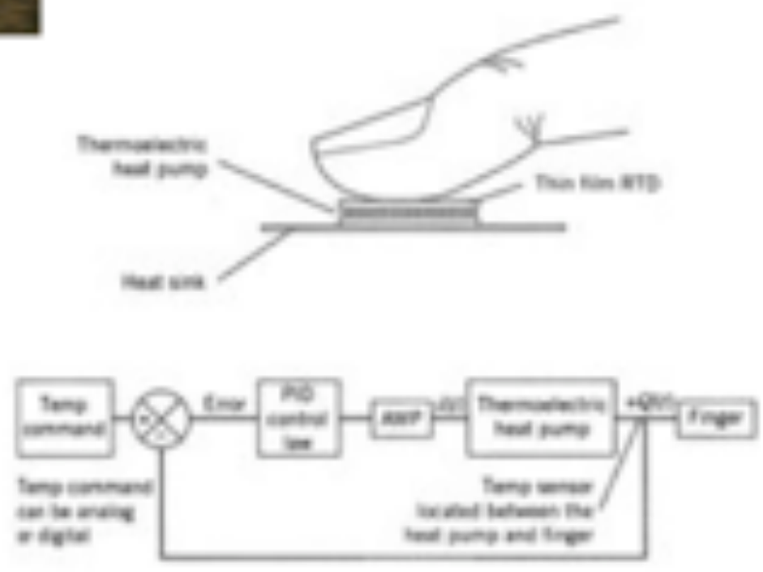
Samsung, et al.

Winfield & Colgate (2007)

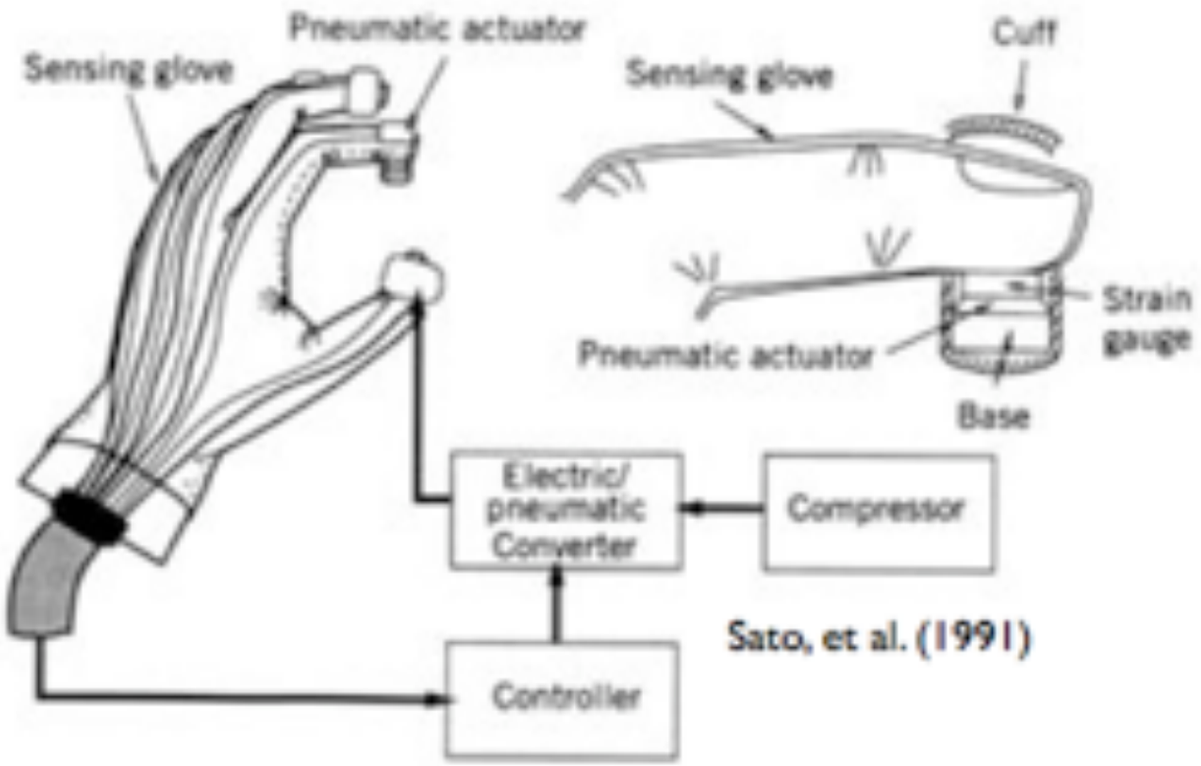


Salada, et al. (2002-5)



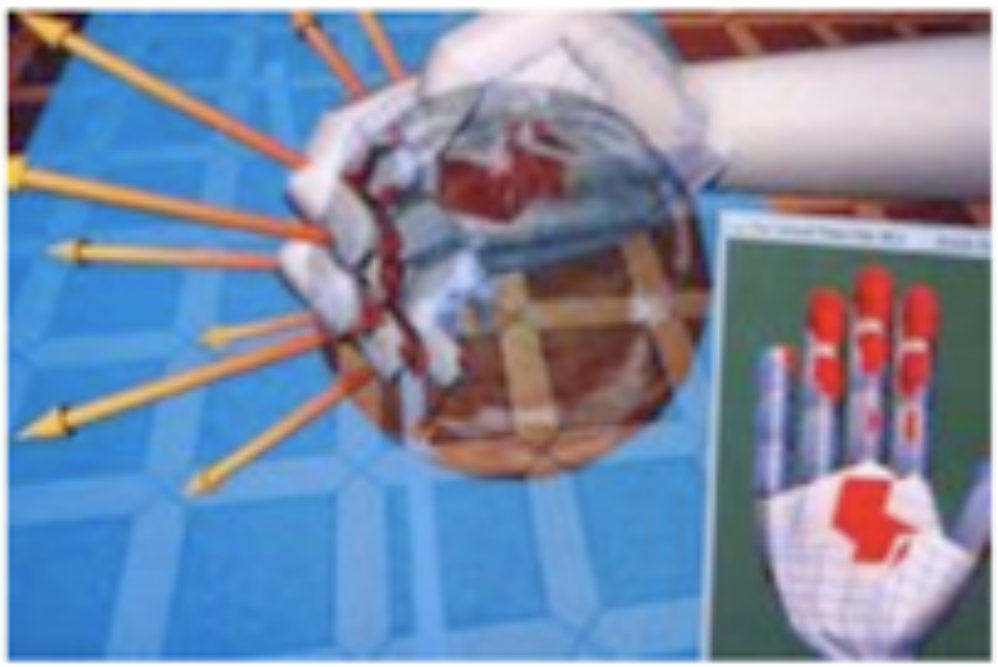


Zerkus (1993)

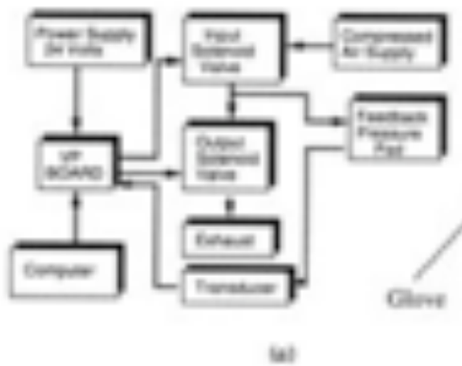


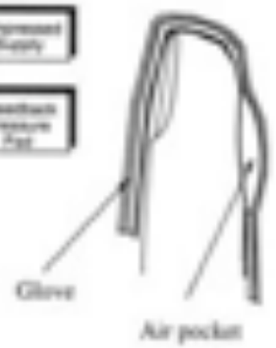
Sato, et al. (1991)

Immersion CyberTouch Glove

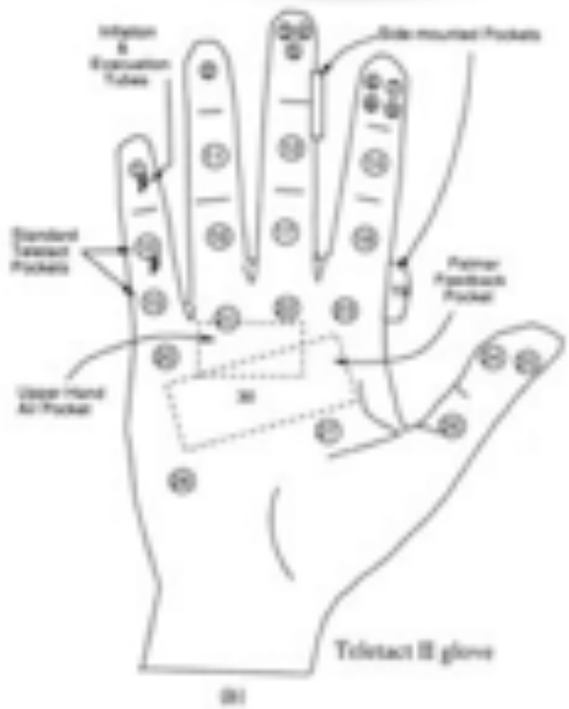


Burdea (1996)





Stone (1992)



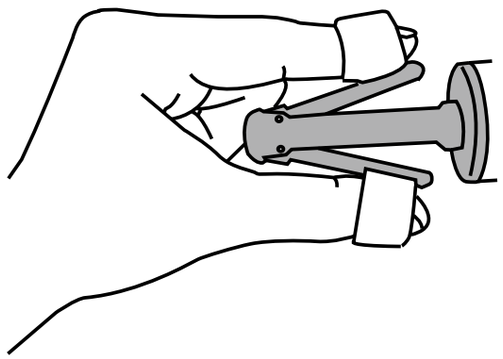
kinesthetic (force-feedback) device basics

typical kinesthetic device configurations

manipulandum

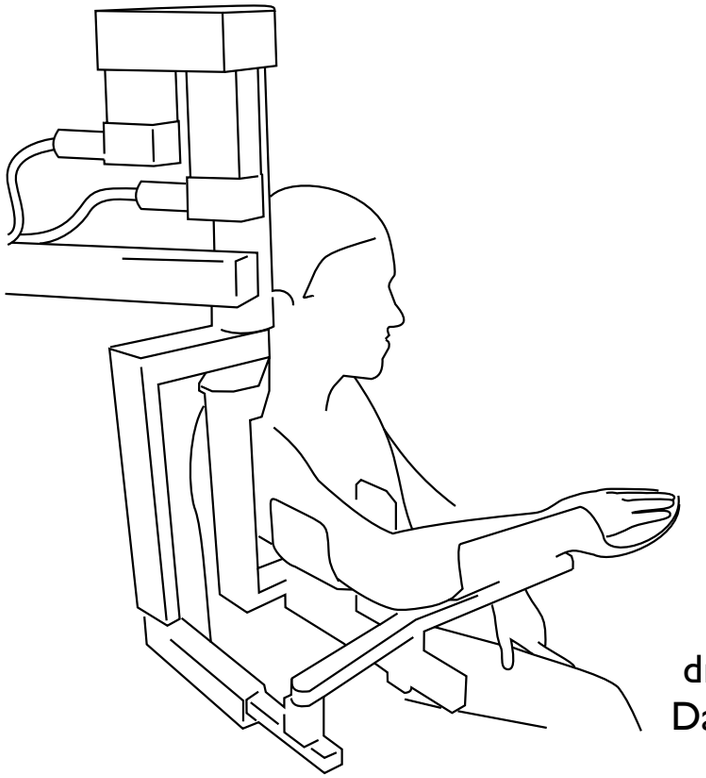
drawing by Jorge Cham

grasp



drawing by Tricia Gibo

exoskeleton



drawing by David Grow

manipulandums (expensive)

Omega
from Force Dimension

delta configuration
3 degrees of freedom

Phantom Premium 1.5
from SensAble/Geomagic

5-bar + rotation
3 degrees of freedom

Virtuose
from Haption

additional "wrist"
6 degrees of freedom

all images from Wikimedia Commons

manipulandums (cheaper)

Falcon
from Novint

delta configuration
3 degrees of freedom

image from Wikimedia Commons

Phantom Omni/Touch
from SensAble/Geomagic

5-bar + rotation
3 degrees of freedom

photographed by Akiko Nabeshima

Sidewinder
from Microsoft

spherical mechanism
2 degrees of freedom

image from Wikimedia Commons

Grip/grasp

Custom haptic gripper for Phantom Premium

Single-finger Cybergrasp from Cyberglove Systems

photograph courtesy
Stanford Center for Design Research

da Vinci Surgical System from Intuitive Surgical, Inc. (no programmable force feedback on gripper)

photographed by Akiko Nabeshima

Exoskeletons

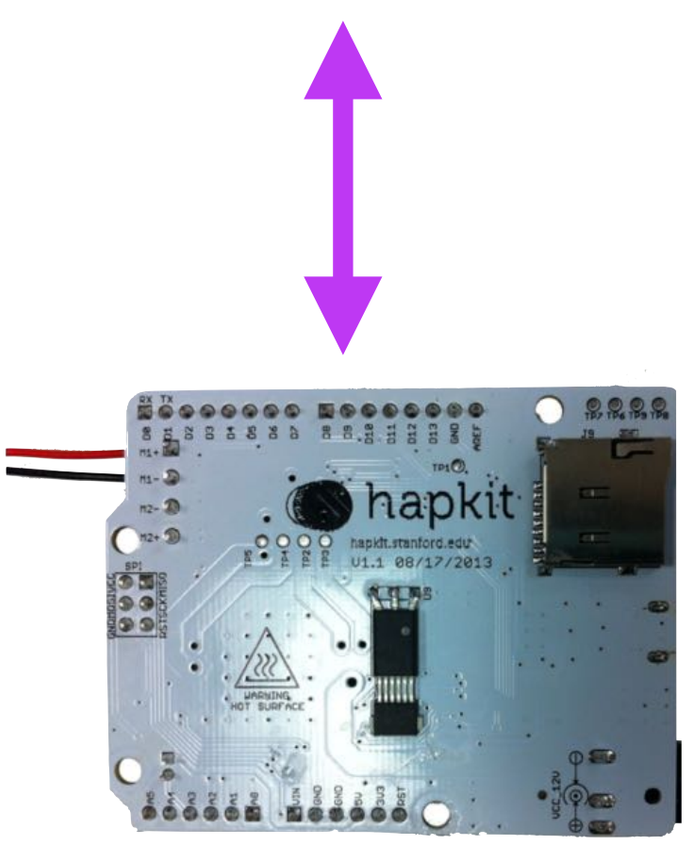
KINARM Exoskeleton
from BKIN Technologies

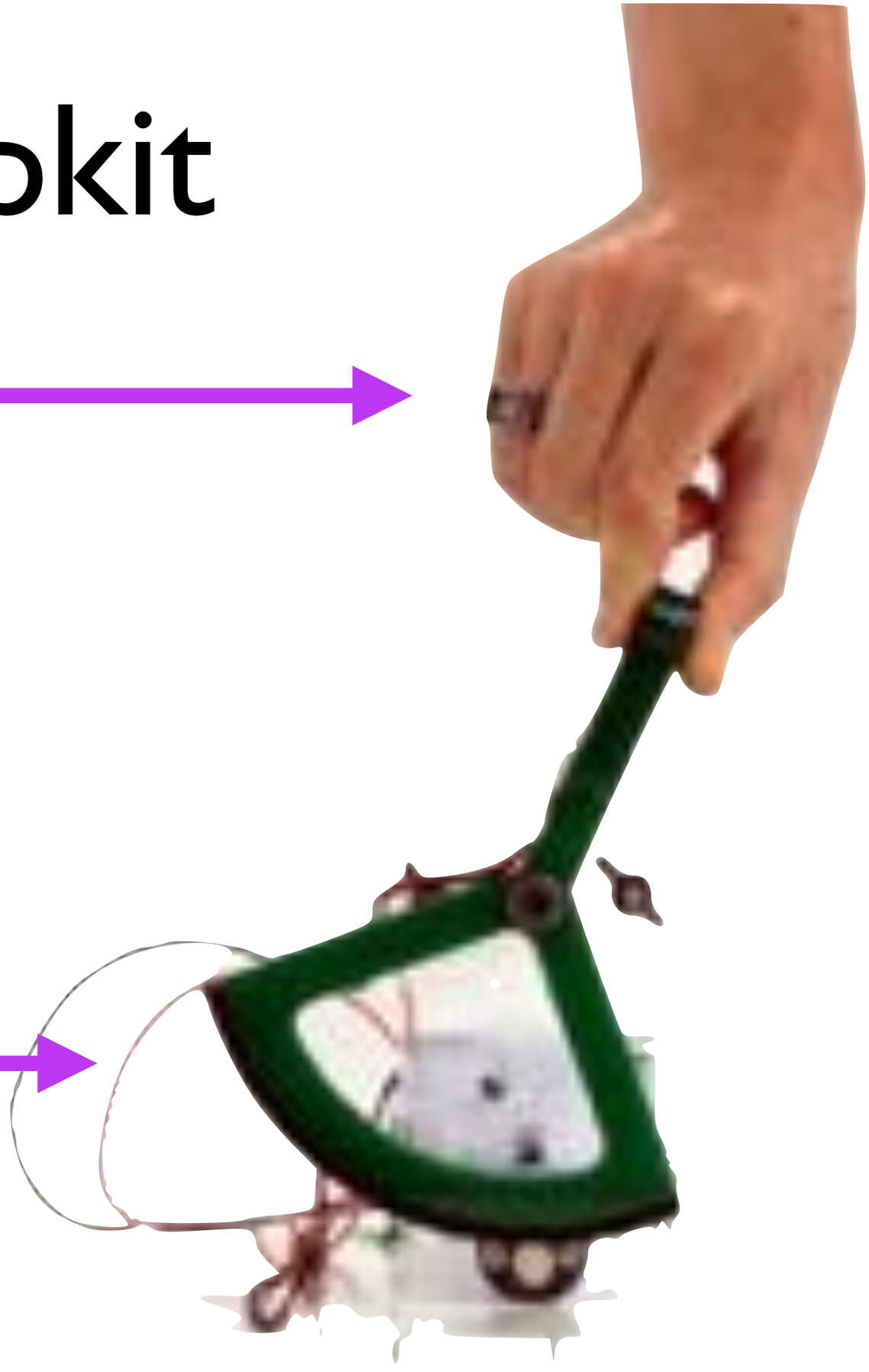
Harvard

DARPA

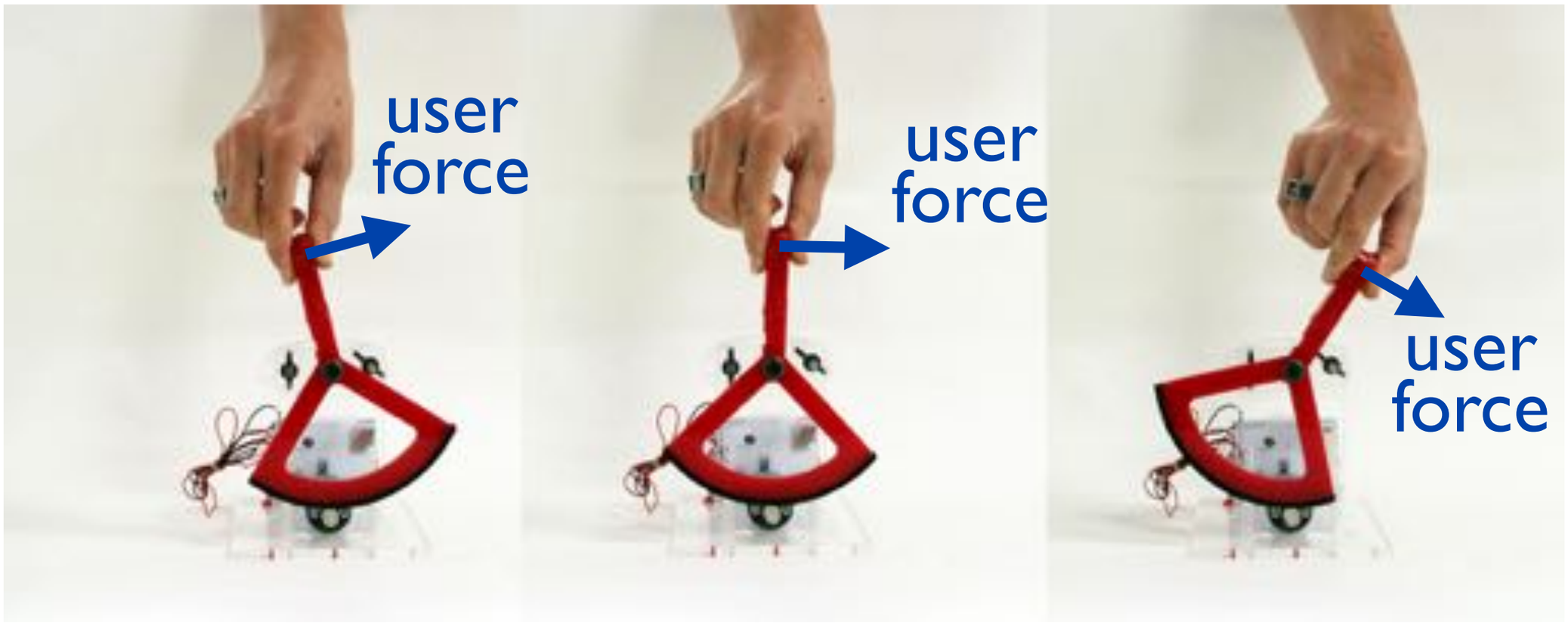
images from Wikimedia Commons

Hapkit

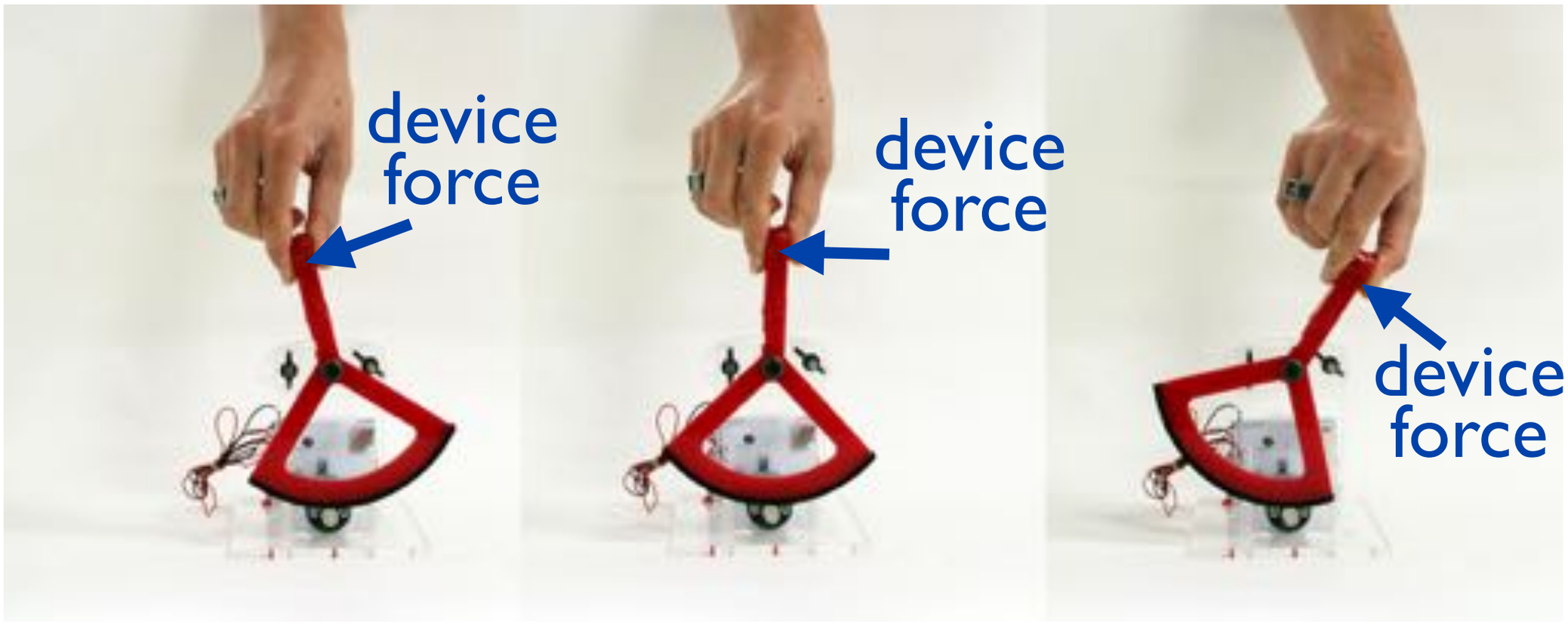




Hapkit



Hapkit



what are haptic devices good for?

this reviews points made in:

K. E. MacLean. Haptic interaction design for everyday interfaces. Reviews of Human Factors and Ergonomics, 4:149-194, 2008.

Trends driving haptics

- Networking - constant connectivity
- Ubiquity of computing devices - beyond sparse visual real estate
- Multitasking - doing more things at once may benefit from multiple channels of communcation
- Virtualization - fostering presence
- Information management - volume challenge and attention challenge
- Fragmentation - time slicing interruptions by modality

When to use haptic feedback

- Precise force vs. position control
- Guidance (for training or shared control)
- Abstract communication and information display
- Notifications and background awareness
- Augmentation of graphical user interfaces
- Expressive control
- Communication of affect
- Mobile and handheld computing

