



# ME 327: Design and Control of Haptic Systems

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## Lecture I: Introduction to haptics

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# today's objectives

introduce you to the field of haptics

(definition, why it is important, and why haptic technology is challenging)

# what is haptics?

hearing

sight

smell

taste

touch

**which sense is  
most valuable  
to you?**

**which would  
you relinquish  
last?**

# hap·tic ('hap-tik)

adj. Of or relating to the sense of touch.

[Greek *haptikos*, from *haptesthai*, to grasp, touch. (1890)]

## Cutaneous

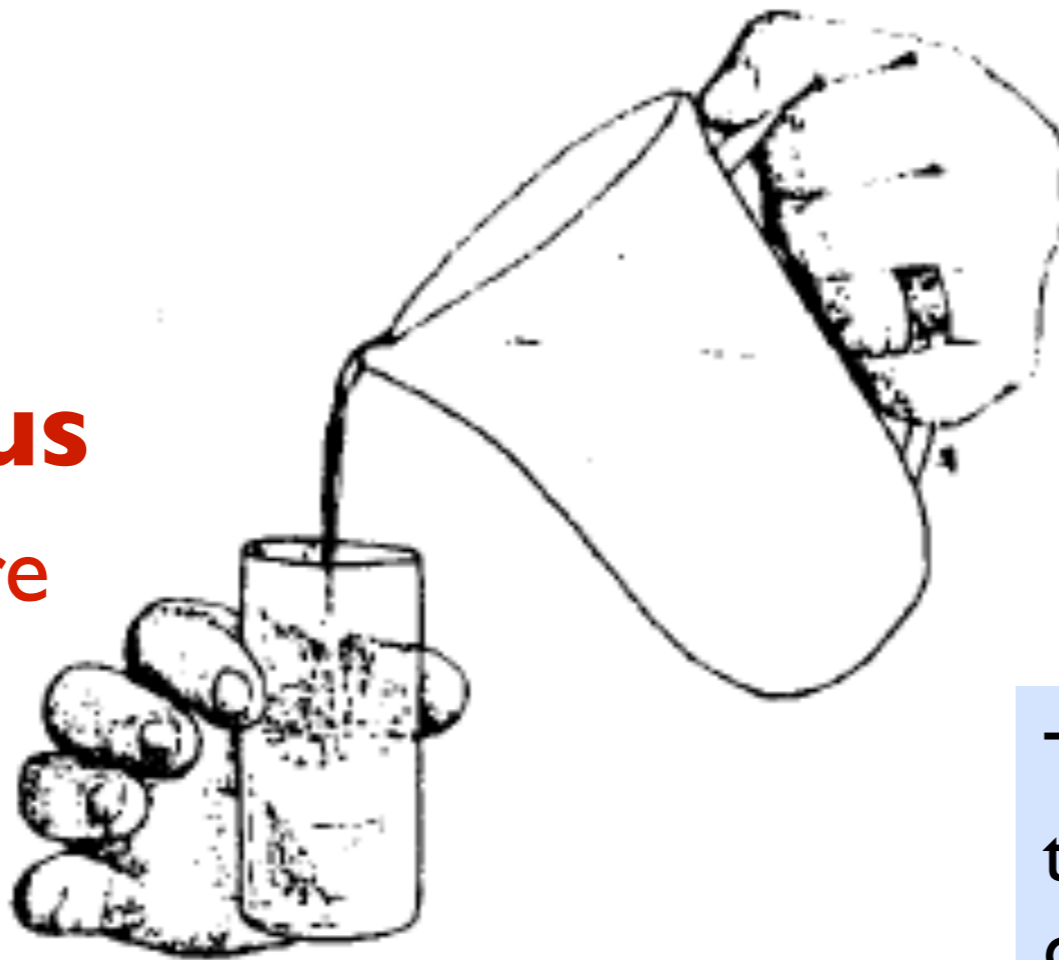
Temperature

Texture

Slip

Vibration

Force



Johansson and Westling

## Kinesthesia

Location/configuration

Motion

Force

Compliance

The haptic senses work together with the motor control system to:

- Coordinate movement
- Enable perception

# what would life be like without touch?



## Cutaneous

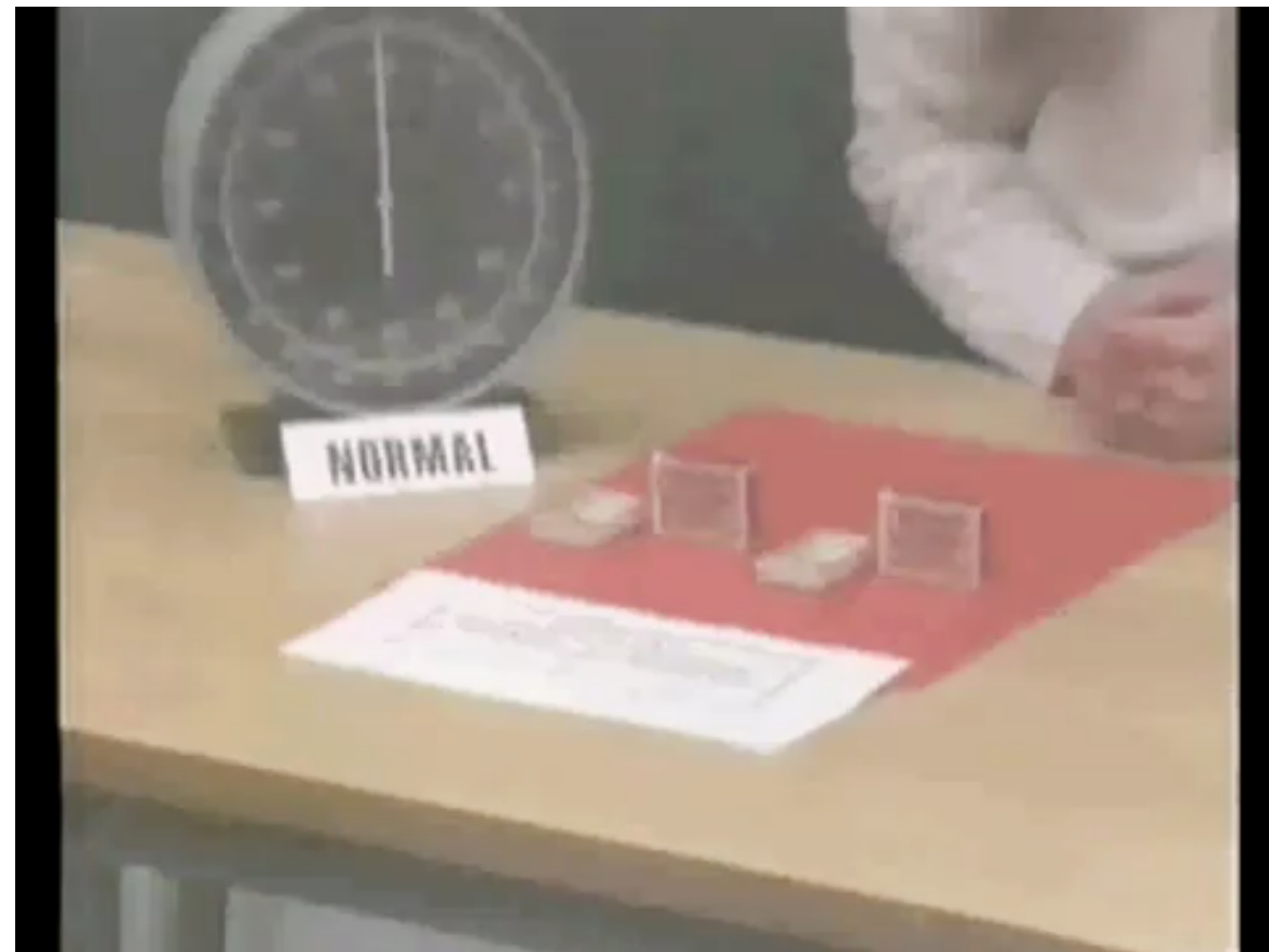
<https://www.youtube.com/watch?v=0Lfj3M3Kn80>



## Kinesthesia

<http://www.youtube.com/watch?v=FKxyJfE83IQ>

# what would life be like without touch?



Pre-anesthetization



Post-anesthetization

video courtesy Roland Johansson

# why do we have brains?



sea  
squirt



# sight

centralized  
broad  
passive  
cognitive

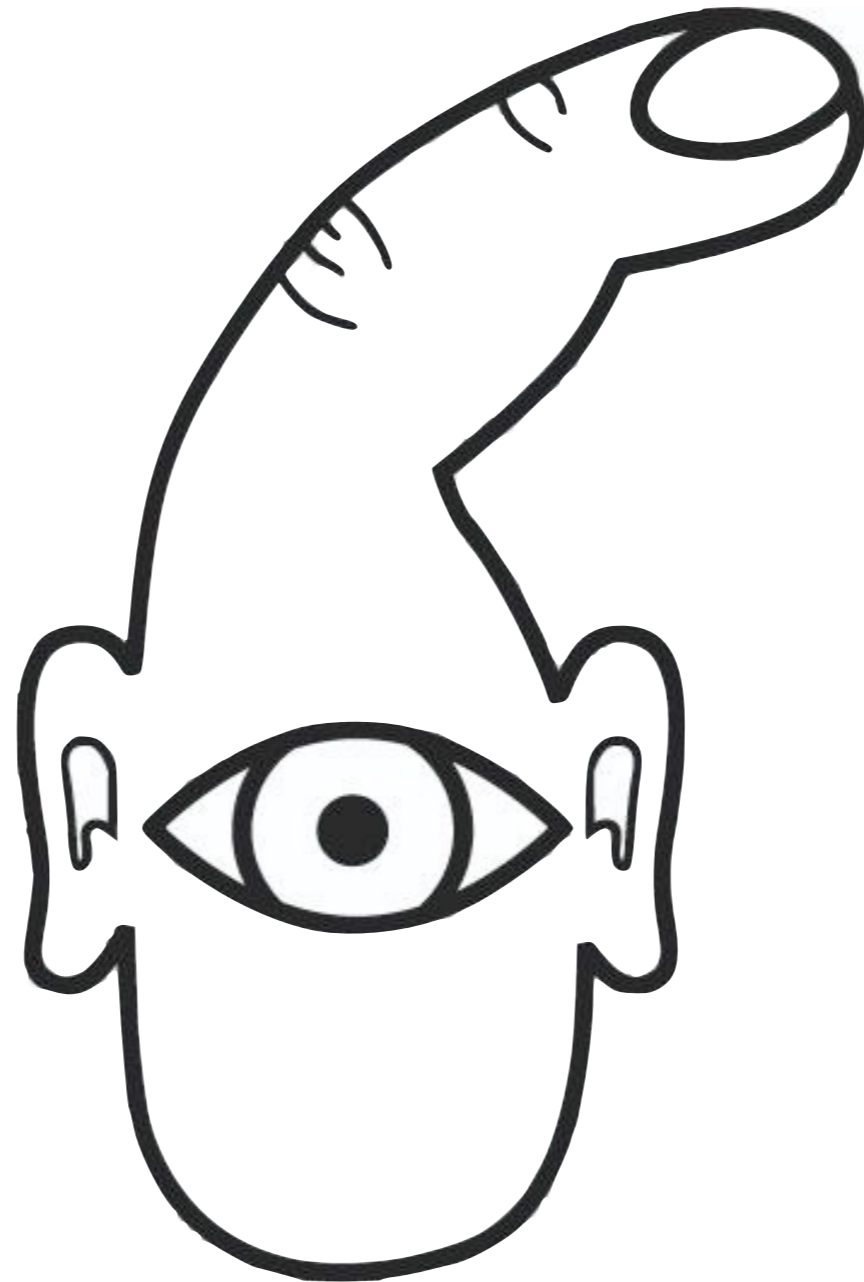


# touch

distributed  
narrow  
active  
physical



# how does your computer/ smartphone/iPad see you?



# what if...

you could make any surface  
feel fuzzy, sticky, soft...?

you could touch  
priceless works of art?

there was a haptic holodeck?

haptics could *teach* you?

<b>Learning Method</b>	<b>Retention</b>
What one reads	10%
What one hears	26%
What one sees	30%
What one sees and hears	50%
What one speaks	70%

what about what one *feels*?

J.E. Stice, Engineering Education, pp. 291-296, 1987

# haptic metaphors

## Emotion

Touching, tactful, stroke one's ego

## Exploration

Get a feel for, poke around, scratch the surface

## Contact

At one's fingertips, touch base, keep in touch, on/at hand

## Constraint/Manipulation

Get a grip, massage an ego, pushy, magic touch

## Surface Properties

Sticky situation, hot idea, abrasive personality, smooth operator

# **haptic box**



**Pass it around. Feel inside.  
Try to identify three objects.**

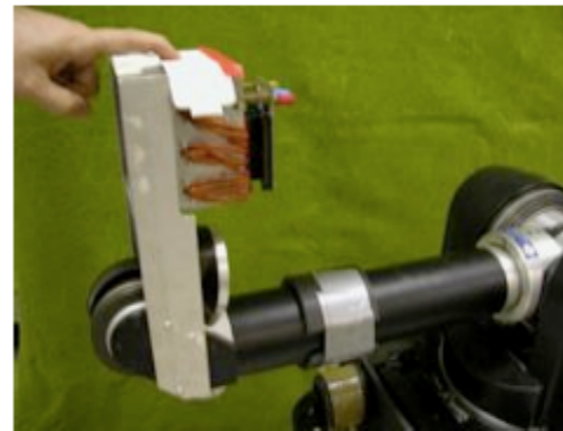
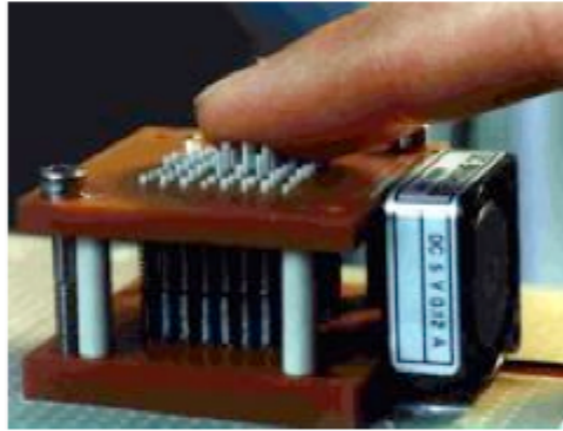
**What was in there?  
How did you know?**

# tactual stereognosis

- Tactual = tactile = via the sense of touch
- Stereognosis = the mental perception of three-dimensionality by the senses, usually in reference to perceiving the form of solid objects by touch
- One study (Klatzky et al., 1985) showed that subjects could identify 100 common objects almost perfectly, taking about 2 seconds per object.
- People are *very good* at tactual stereognosis.

## Tactile Devices

Stimulate skin to create contact sensations



## Hybrid Devices

Attempt to combine tactile and kinesthetic feedback



## Kinesthetic Devices

Apply forces to guide or inhibit body movement



# existing applications of haptics

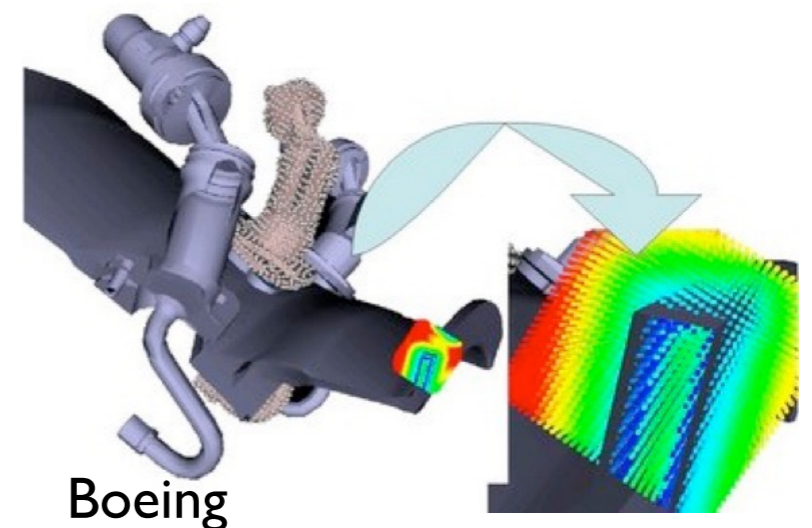
## entertainment



## education



## human-computer interfaces



# course overview

# course objectives

by the end of this course, you should:

- know the basics of human haptics and how this influences design
- understand selected topics in haptics for mobile/wearable devices, virtual environments, and teleoperation
- build on your knowledge of dynamic systems and controls
- improve your research and presentation skills