Human Factors 1

CSE333: Introduction to Human-Computer Interaction

Spring 2023

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The Human Factor

- **Computers** function according to their programmed capabilities.
- **Humans** are complicated and differ across many dimensions
  - Young, old, tall, short, fast, slow
  - Experts, novices, strong, weak
  - Able-bodied, disabled, sighted, blind
  - Motivated, lazy, tired, alert

- No interface can work well for every user
  - “Know thy user” – Shneiderman and Plaisant, 2005, p66

Understanding the Human

The more we understand humans, the better are our chances of designing interactive systems that work as intended

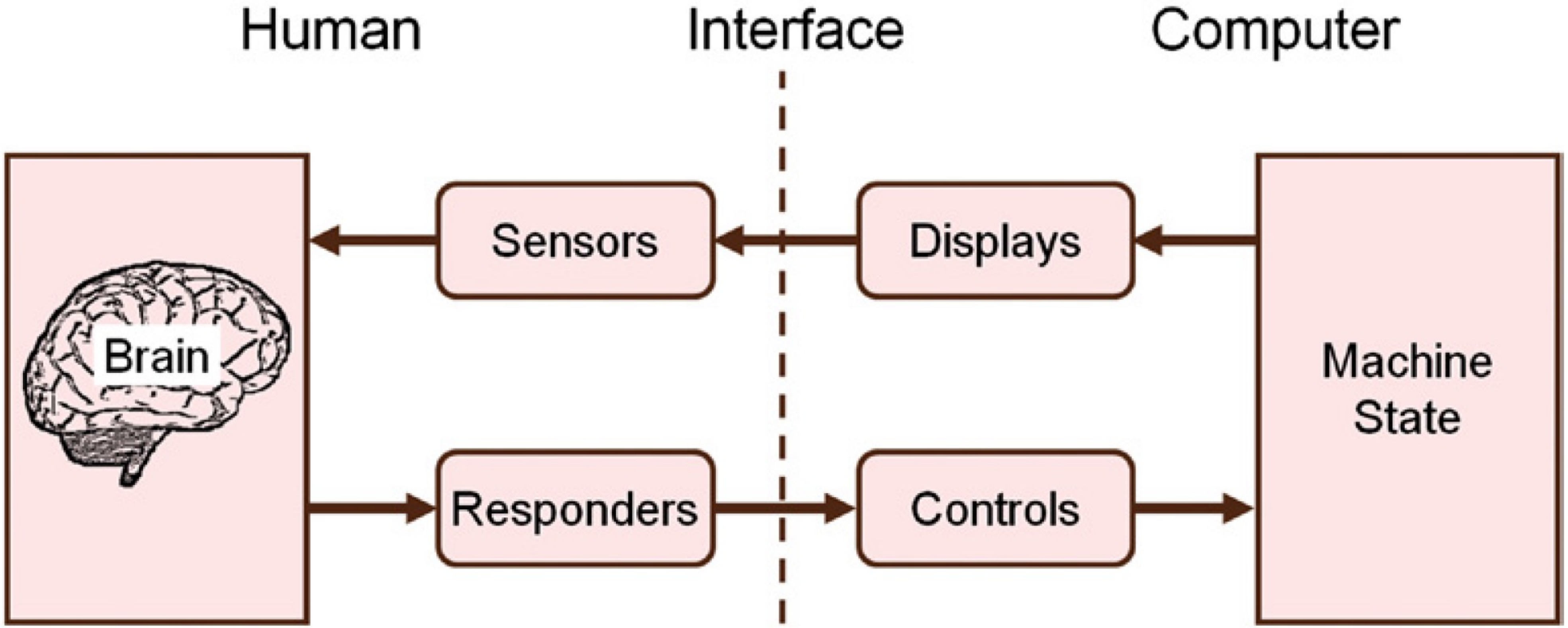
- Why do humans make mistakes?
- Why do humans forget how to do things?
- Why do humans get confused while installing apps on their computers?
- Why do humans have trouble driving while talking on a mobile phone?

Understanding the Human

The more we understand humans, the better are our chances of designing interactive systems that work as intended

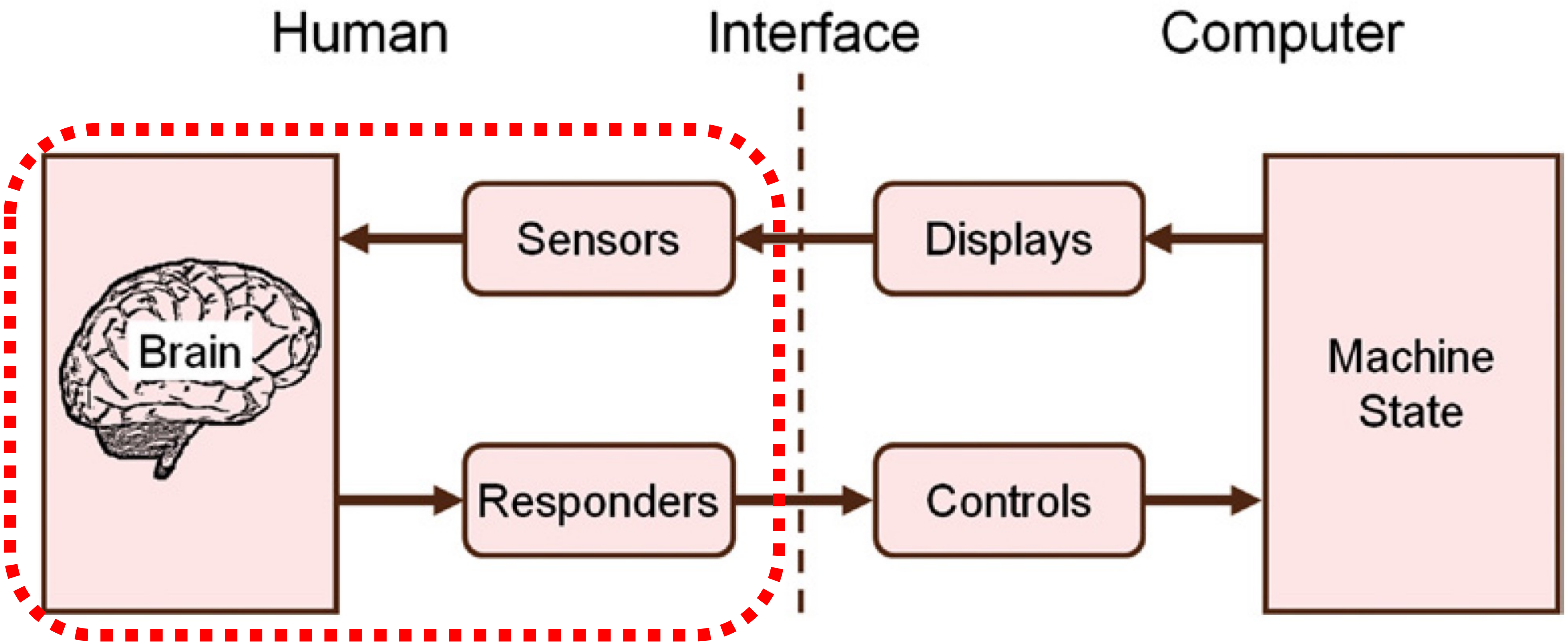
- You don't like the default iPhone keyboard because there are so many errors. Why is that?
- You build a new keyboard with larger keys for your iPhone. It is really awesome, very fast and convenient. Why is that?

Human Factors Model



Kantowitz, B. H., & Sorkin, R. D. (1983).
Human factors: Understanding People-System Relationships

Human Factors Model



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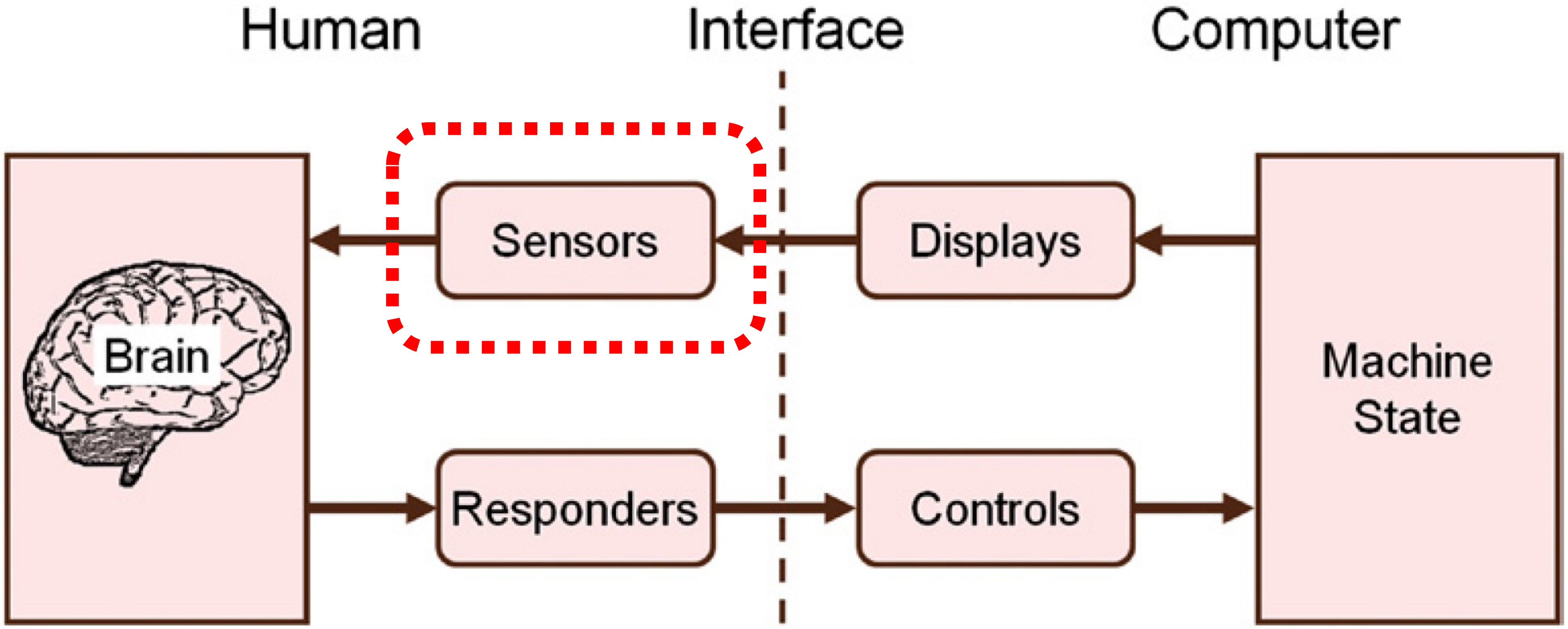
Human Factors Model

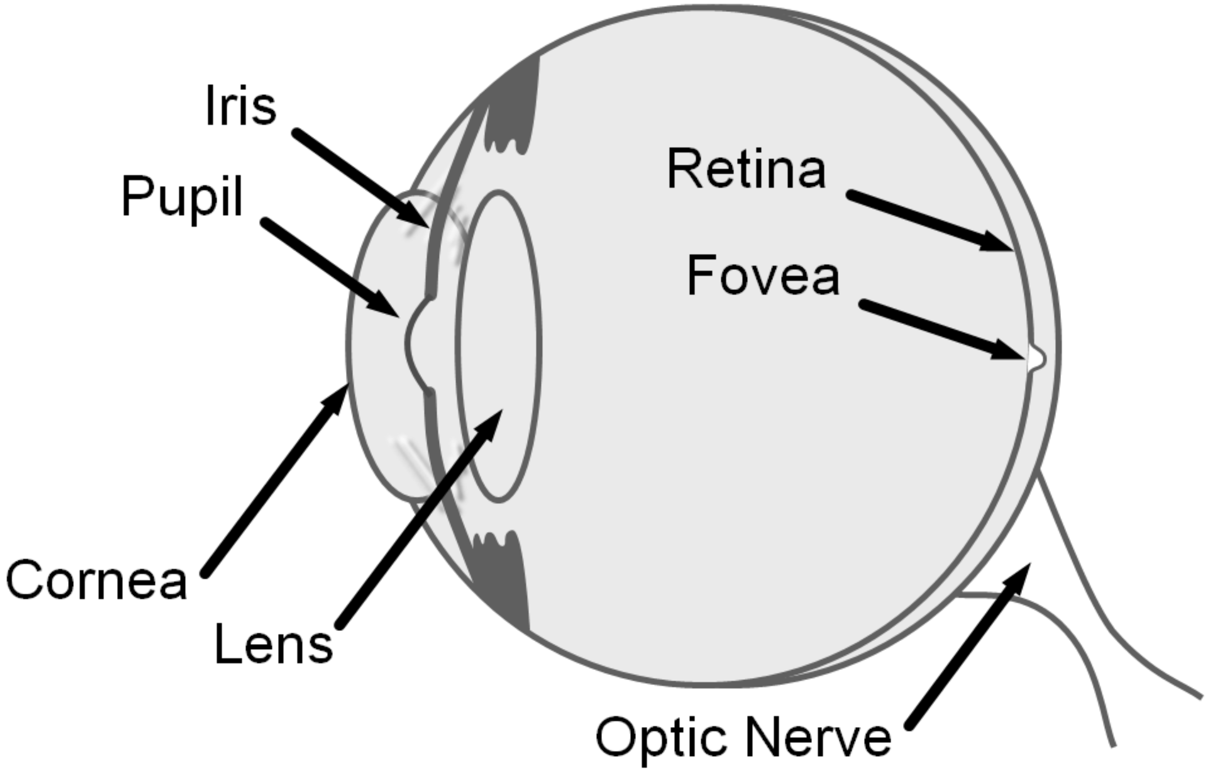


Human Senses

- Vision (sight)
- Hearing (audition)
- Touch (tactition)
- Smell
- Taste

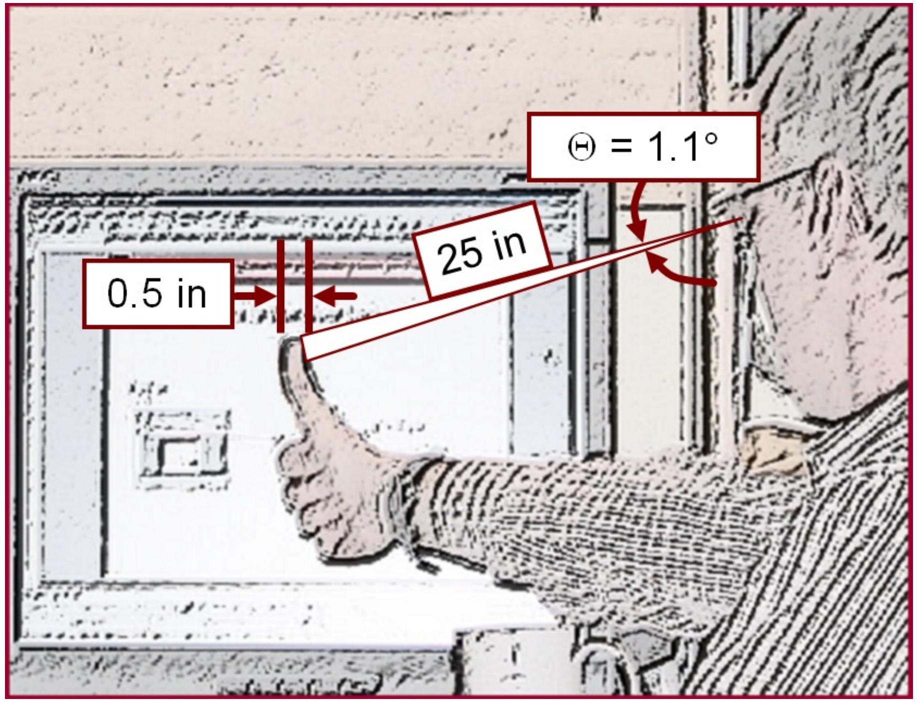
Vision (The Eye)

- People obtain about 80% of their information through the sense of light.



Fovea Image

- Sharp central vision
- 1% of retina, 50% of visual cortex
- Fovea image is ≈1° of visual angle:

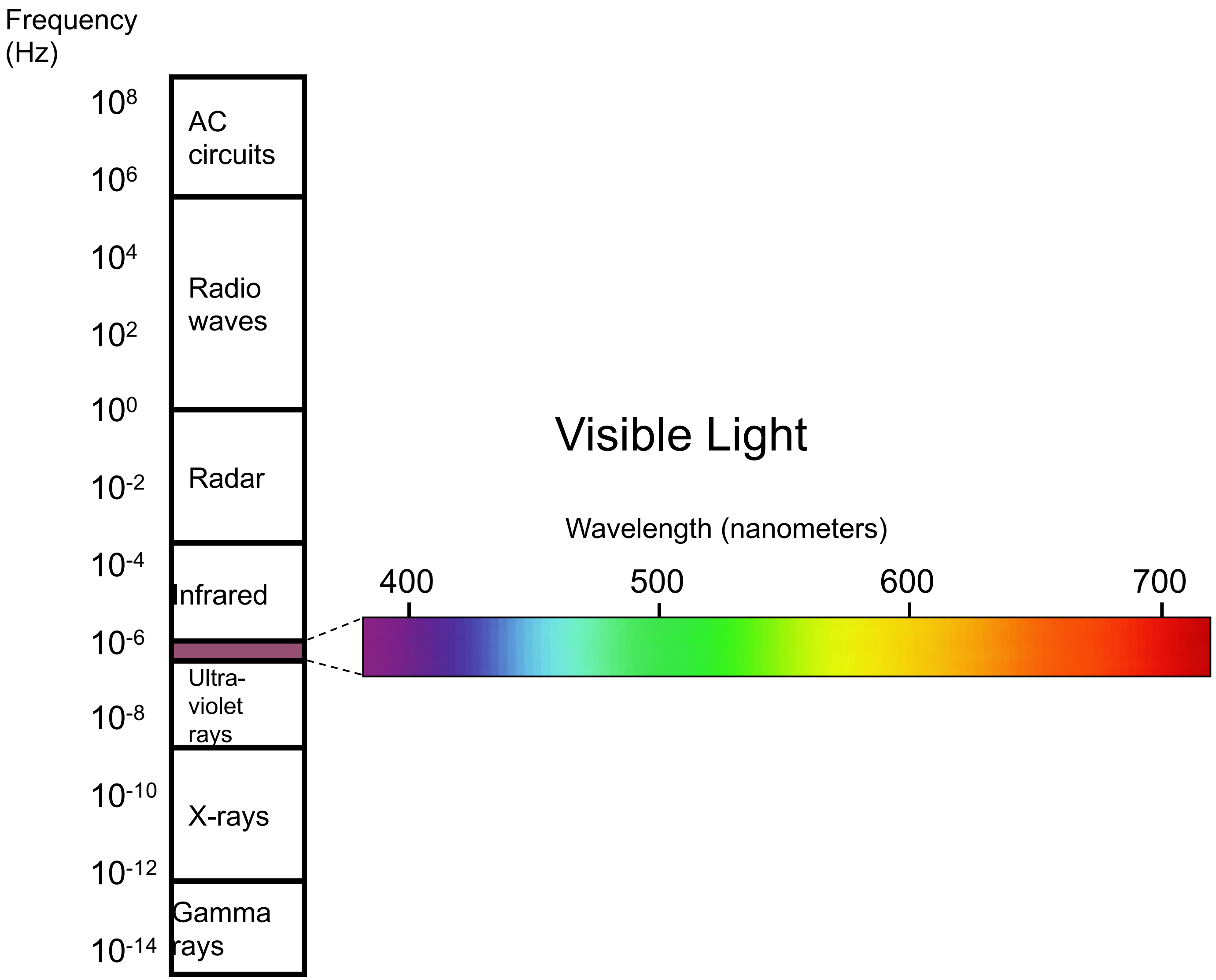


Visual Stimulus

- Physical properties of light…
  - Frequency
  - Intensity (luminance)

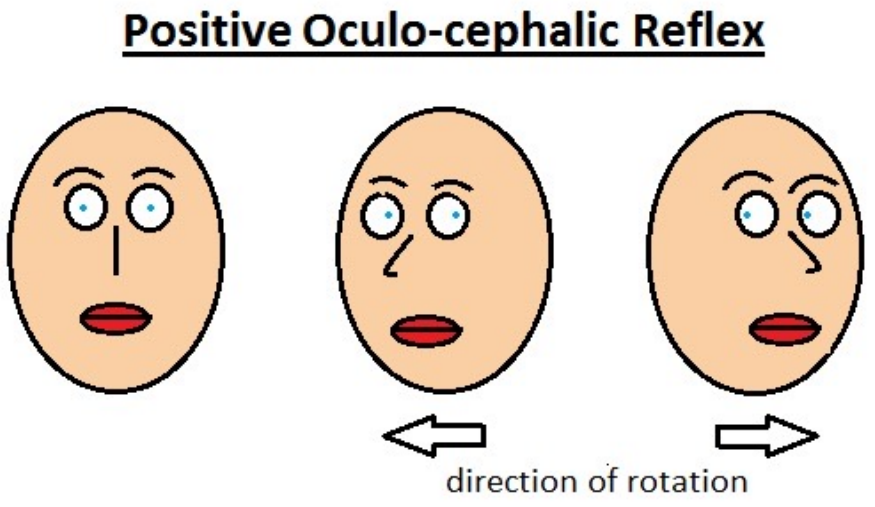
- Create subjective properties of vision…
  - Color
  - Brightness

Color Spectrum



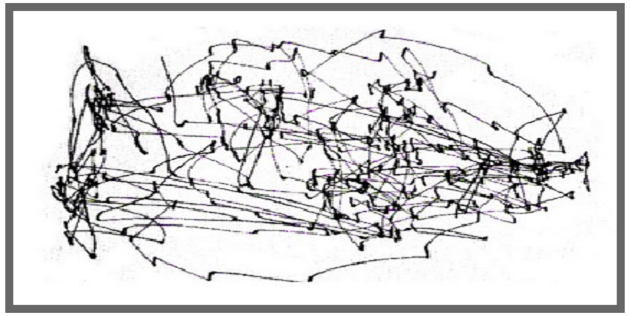
Types of eye movements

- Maintain gaze
  - VOR (vestibulo-ocular Reflex)
  - Fixation
- Change gaze
  - VOR cancellation
  - Saccade
  - Smooth pursuit
  - Vergence

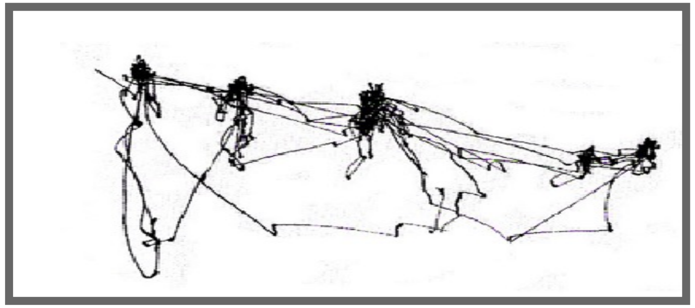


Yarbus' Eye Tracking Research (1965)[1]

The Unwanted Visitor
by Ilya Repin (1844-1930)



"Remember the position of people and objects in the room"

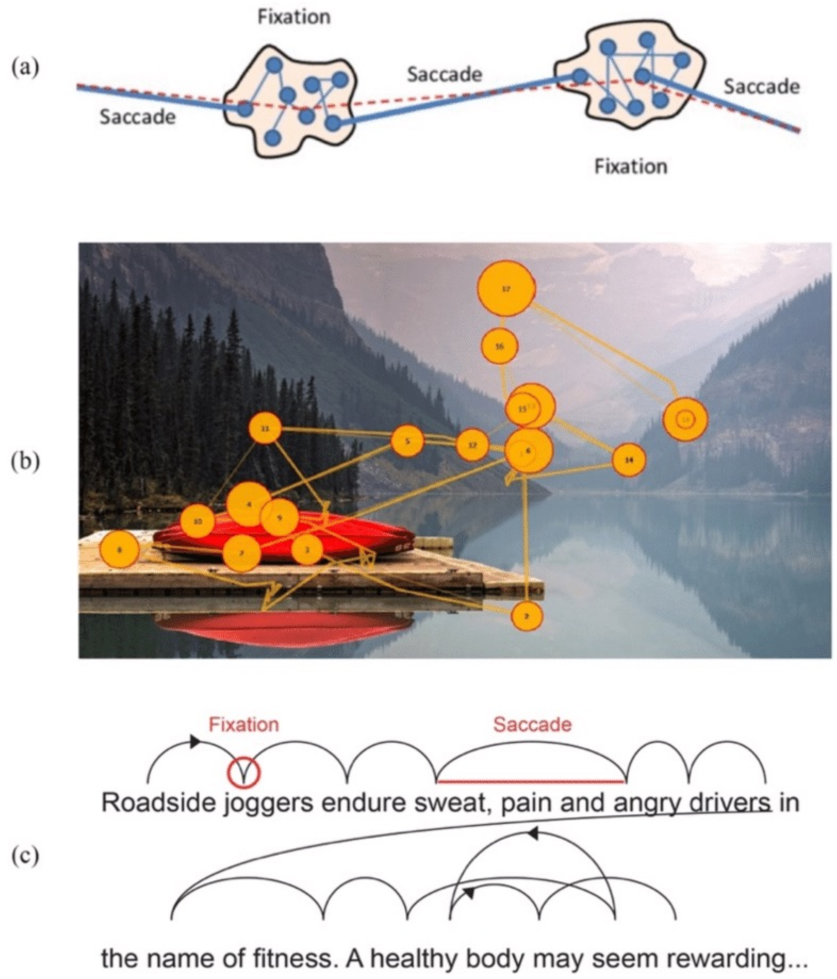


"Estimate the ages of the people"

[1] Tatler, B. W., Wade, N. J., Kwan, H., Findlay, J. M., & Velichkovsky, B. M. (2010). Yarbus, eye movements, and vision. *i-Perception, 1*, 7-27..

Scan Paths

- Visual depiction of saccades and fixations
- Saccades → straight lines
- Fixations → circles
  - Diameter of circle ∝ duration of fixation
- Applications
  - User behaviour research (e.g., reading patterns
  - Marketing research (e.g., ad placement)



Mise-Unseen

using eye tracking to hide virtual reality scene changes in plain sight

sebastian marwecki[1,2], andrew d. wilson[1], eyal ofek[1], mar gonzalez franco[1], christian holz[1]
[1]microsoft research, redmond, wa, usa, [2]hasso plattner institute, university of potsdam, germany

Microsoft | Research

Sebastian Marwecki, Andrew D. Wilson, Eyal Ofek, Mar Gonzalez Franco, and Christian Holz.
Mise-Unseen: Using Eye Tracking to Hide Virtual Reality Scene Changes in Plain Sight. UIST 2019

Gaze and Touch Interaction on Tablets

Ken Pfeuffer, Hans Gellersen
Lancaster University
k.pfeuffer@lancaster.ac.uk, hwg@comp.lancs.ac.uk

Esteves, Augusto, et al. Orbits: Gaze interaction for smart watches using smooth pursuit eye movements. UIST 2015.

Hearing (Audition)

- Sound → cyclic fluctuations of pressure in a medium, such as air
- Created when physical objects are moved or vibrated
- Examples
  - Slamming a door, plucking a guitar string, shuffling cards, speaking

- Physical properties of sound
  - Frequency
  - Intensity

→

Subjective properties of hearing

- Pitch
- Loudness
- Timbre
- Attack

Intensity and Frequency of Sound

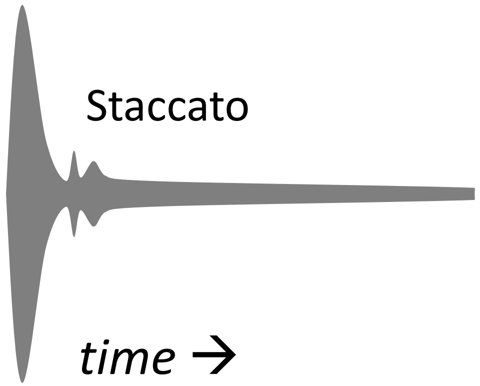
- Loudness
  - Subjective analog to the physical property of intensity (in decibel (dB))
  - 0–10 dB - audible; 50–70 dB - conversational speech; 120–140 dB - pain.
- Pitch
  - Subjective analog of frequency (in Hertz (Hz))
  - Audible range: 20 Hz–20,000 Hz (20 kHz)

Timbre

- Aka *richness*, *brightness*
- Results from harmonic structure of sound
- E.g., a musical note of 200 Hz, has harmonics at 400 Hz, 600 Hz, 800 Hz, etc.
- Notes of the same frequency from different instruments are distinguished, in part, due to timbre

Attack

- Aka *envelope*
- Results from the way a note and its harmonics build up and transition in time – from silent, to audible, to silent
- Considerable information in the onset envelop
- Onset envelop created through articulation (e.g., legato, staccato)



Staccato

time →

Legato

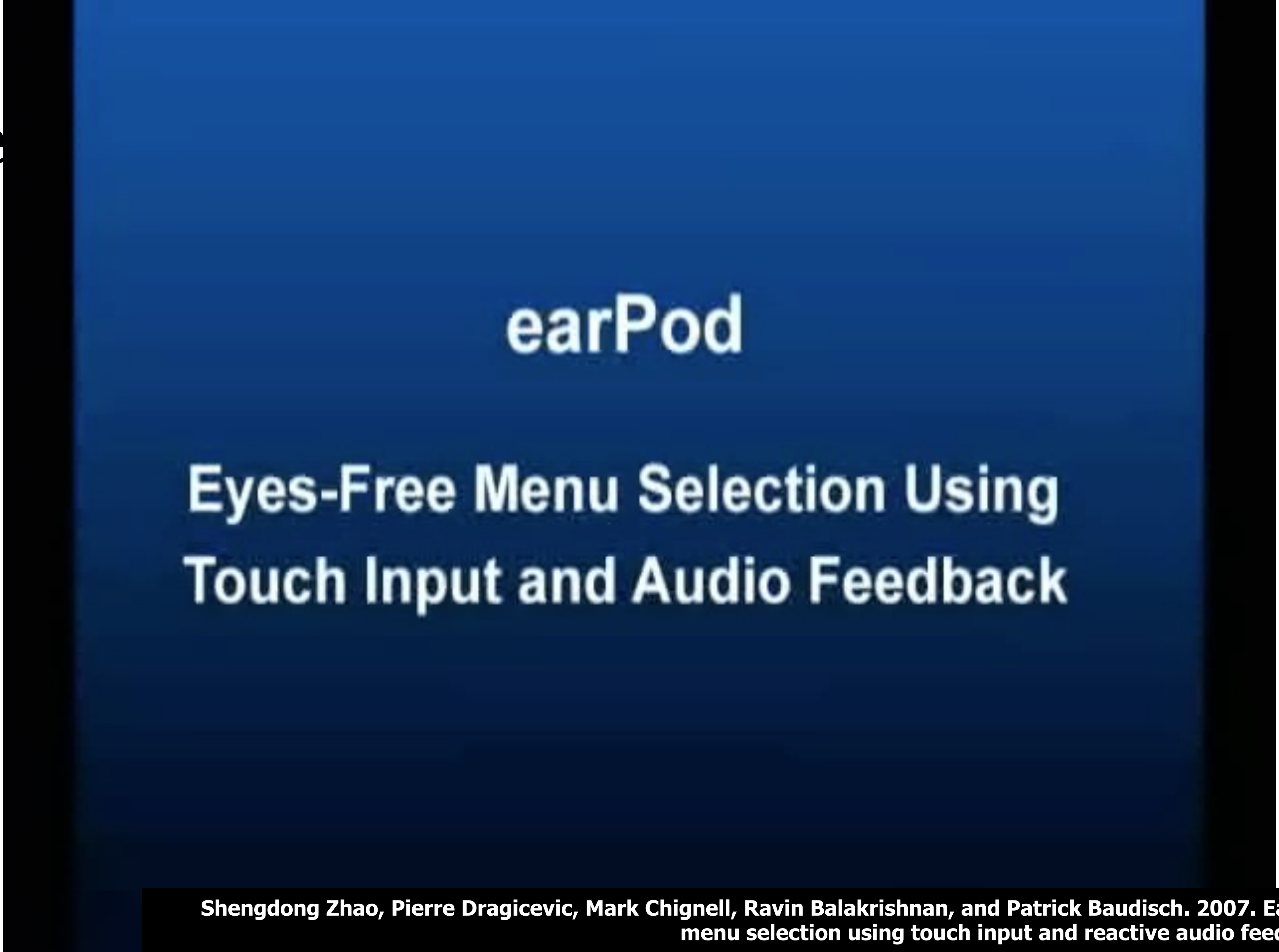
time →

Hearing (Audition)

- Can be used for
  - Notification
  - Immersion
  - Feedback
  - Spatial Awareness

He

- Ca



Shengdong Zhao, Pierre Dragicevic, Mark Chignell, Ravin Balakrishnan, and Patrick Baudisch. 2007. Earpod: eyes-free menu selection using touch input and reactive audio feedback. CHI 2007

HindSight

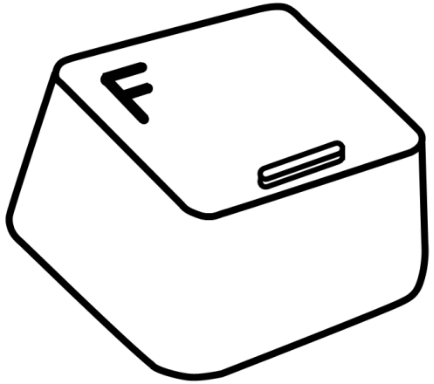
Enhancing Spatial Awareness by Sonifying Detected Objects in Real-Time 360-Degree Video

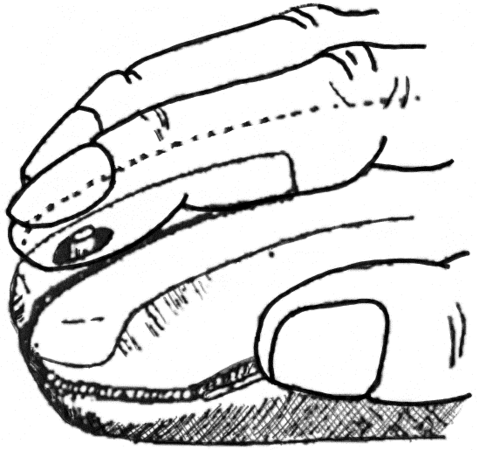
Eldon Schoop
James Smith
Bjoern Hartmann

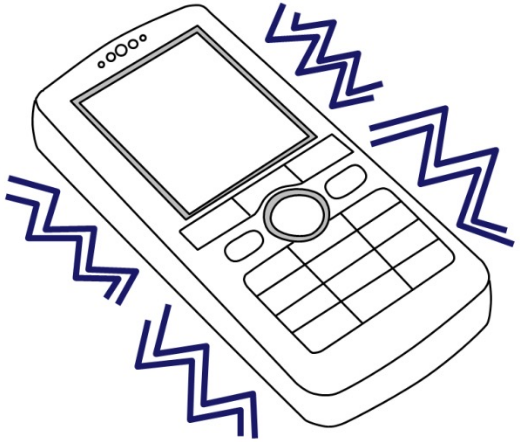
CHI 2018

Touch (Tactition)

- Part of somatosensory system, with…
- Receptors in skin, muscles, joints, bones
  - Sense of touch, pain, temperature, position, shape, texture, resistance, etc.
- Tactile feedback examples:







Touch and Tactile Feedback

Guiding directions

Notifications

Feedback

Touch and Tactile Feedback

A new sense of time.
Enjoy every second.

The Dot Watch lets you experience time in a completely new way:
without sound, just by yourself. It provides direct access to all the
practical features you need so many times throughout each day
: Time and Date, Alarm Clock, Timer, and Stopwatch.
It tells you the time down to the second. Truly, a new sense of time.

DotWatch, Dot Inc.

Ready Player One (2018)

Touch and Tactile Feedback

bhaptics TactSuit

Smell and Taste

- Smell (olfaction)
  - Ability to perceive odours
  - Occurs through sensory cells in nasal cavity
- Taste (gustation)
  - Chemical reception of sweet, salty, bitter, and sour sensations
- Flavor
  - A perceptual process that combines smell and taste

Seah, S. A. et al., SensaBubble: a chrono-sensory mid-air display of sight and smell. CHI 2014

trigeminal-based temperature illusions

jas brooks, steven nagels, pedro lopes

THE UNIVERSITY OF
CHICAGO

Jas Brooks, Steven Nagels, and Pedro Lopes. Trigeminal-based Temperature Illusions. CHI 2020.

Design Project

- Check the final reports and videos from last year @BB

- Register your team name on the team registration sheet by Tomorrow
- Then the TA will make a group on BB based on the team registration sheet.

- Pre-proposal meetings will be about 30 mins/team in Week 5
- Proposal presentation will be 10 min/team in Week 7 during the class