IMGD 3xxx - HCI for Real, Virtual, and Teleoperated Environments:
Haptic Cues

by

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Haptic Displays

- Haptic sense is most complex
  - Tactile
    - Stimuli on the skin
    - Different kinds of mechanoreceptors, each with varying types of sensitivity
  - Temperature
    - Actually part of tactile
  - Kinesthetic
    - Force on the muscles and tendons
    - Proprioception
    - Force feedback
  - Wind
  - Pain

Haptic Sense

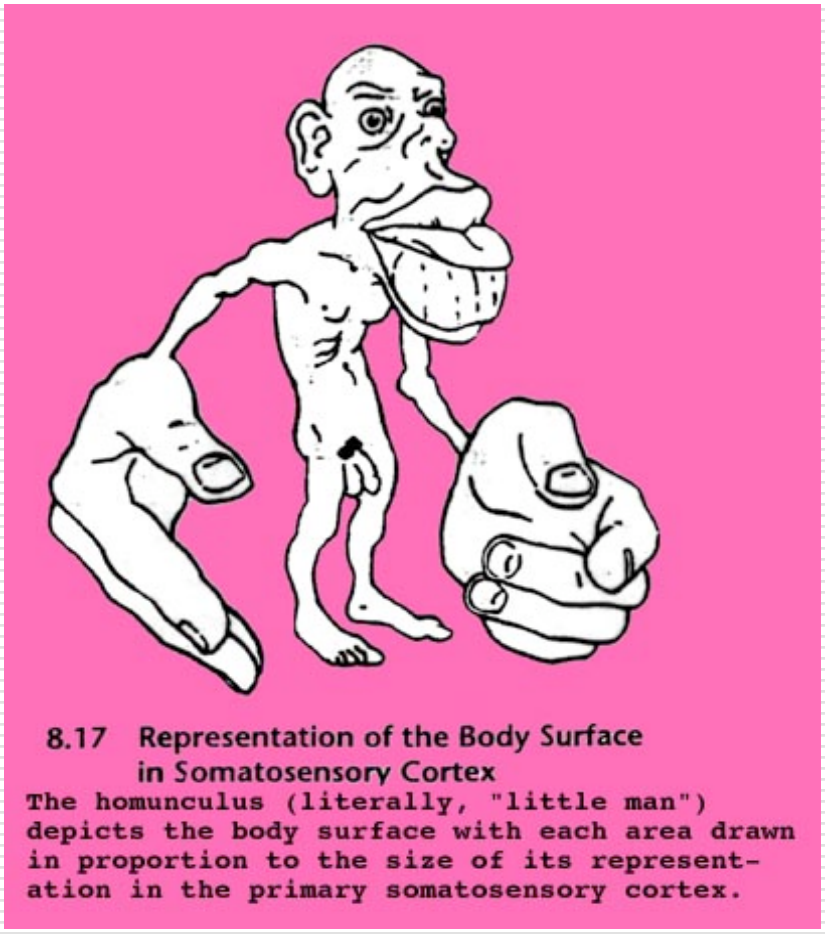
- The haptic sense is bidirectional
  - Senses the environment
  - Acts on the environment
  - Tight coupling between the two
- Skin is the largest organ

Haptic Devices

- Pin arrays for the finger(s)
- Force-feedback "arms"
- "Pager" motors
- Particle brakes
- Passive haptics
- Many devices are application specific
  - Like surgical devices

Haptic Feedback in VR

- Tactile: Surface properties
  - Most densely populated area is the fingertip (okay, it's the tongue)
- Kinesthetic: Muscles, Tendons, etc.
  - Also known as proprioception



8.17 Representation of the Body Surface in Somatosensory Cortex
The homunculus (literally, "little man") depicts the body surface with each area drawn in proportion to the size of its representation in the primary somatosensory cortex.

Haptic Sense (cont)

- Sensitivity varies greatly
  - Two-point discrimination

Body Site	Threshold Distance
Finger	2-3mm
Cheek	6mm
Nose	7mm
Palm	10mm
Forehead	15mm
Foot	20mm
Belly	30mm
Forearm	35mm
Upper Arm	39mm
Back	39mm
Shoulder	41mm
Thigh	42mm
Calf	45mm

http://faculty.washington.edu/chudler/chsense.html

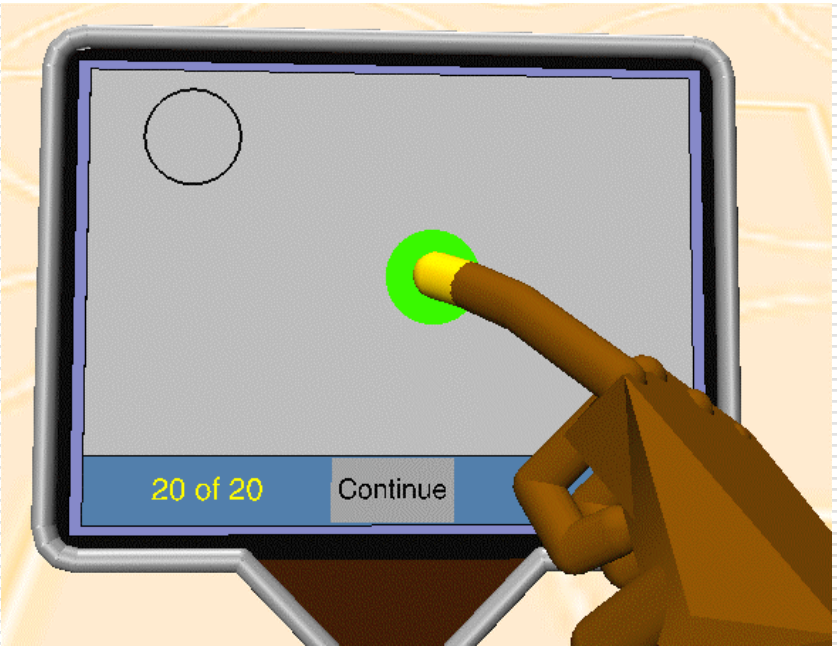
SensAble *PHANToM*

http://www.sensable.com/

Immersion *CyberGrasp*

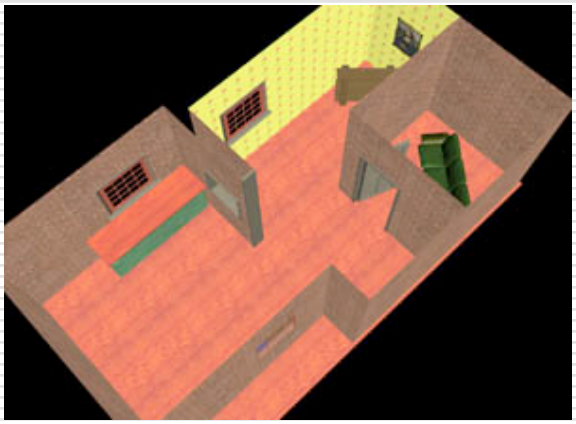
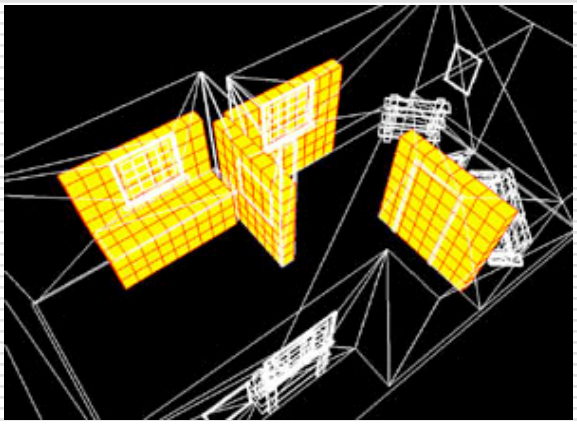
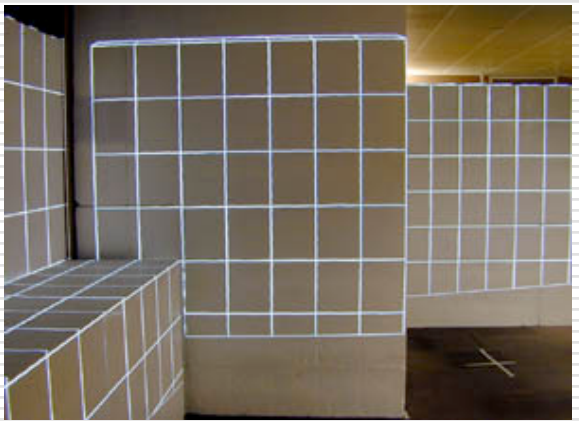
http://www.immersion.com/

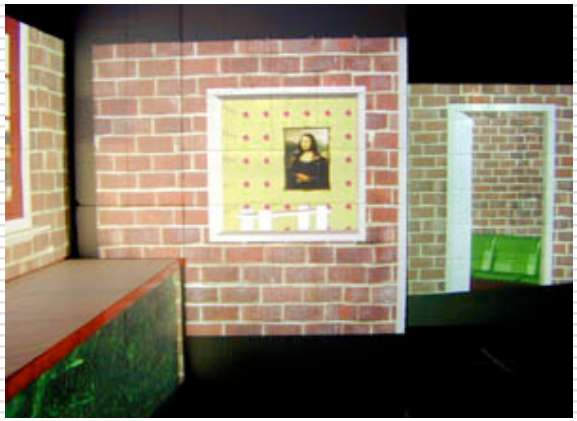
Passive Haptic Paddle



http://www.cs.wpi.edu/~gogo/hive/

UNC Being There Project

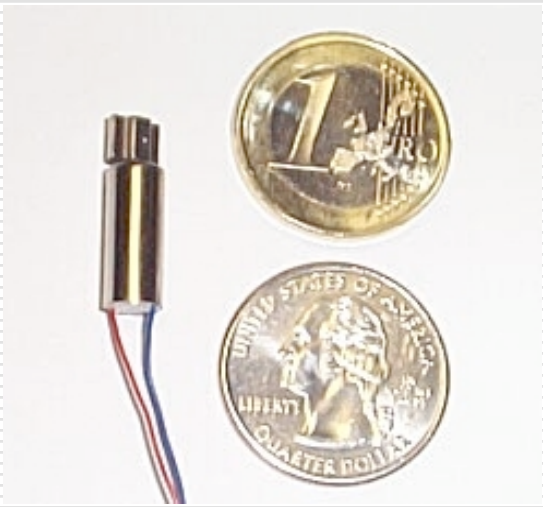


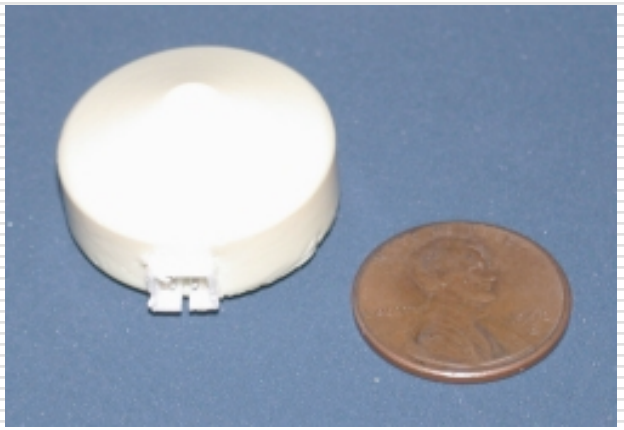
Haptic Feedback in VR

- Virtual contact
  - What should we do when we know that contact has been made with a virtual object?
  - The *output* of collision detection is the *input* to virtual contact
  - Cues for understanding the nature of contact with objects are typically over-simplified (*e.g.*, sound)
- Training aids
  - Can we convey additional information using the haptic channel?

Vibrotactile Cueing Devices

- Vibrotactile feedback has been incorporated into many devices
- Can we use this technology to provide scalable, wearable touch cues?





Vibrotactile Feedback Projects

Navy TSAS Project

TactaBoard and TactaVest