



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

by
Robert W. Lindeman
gogo@wpi.edu

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

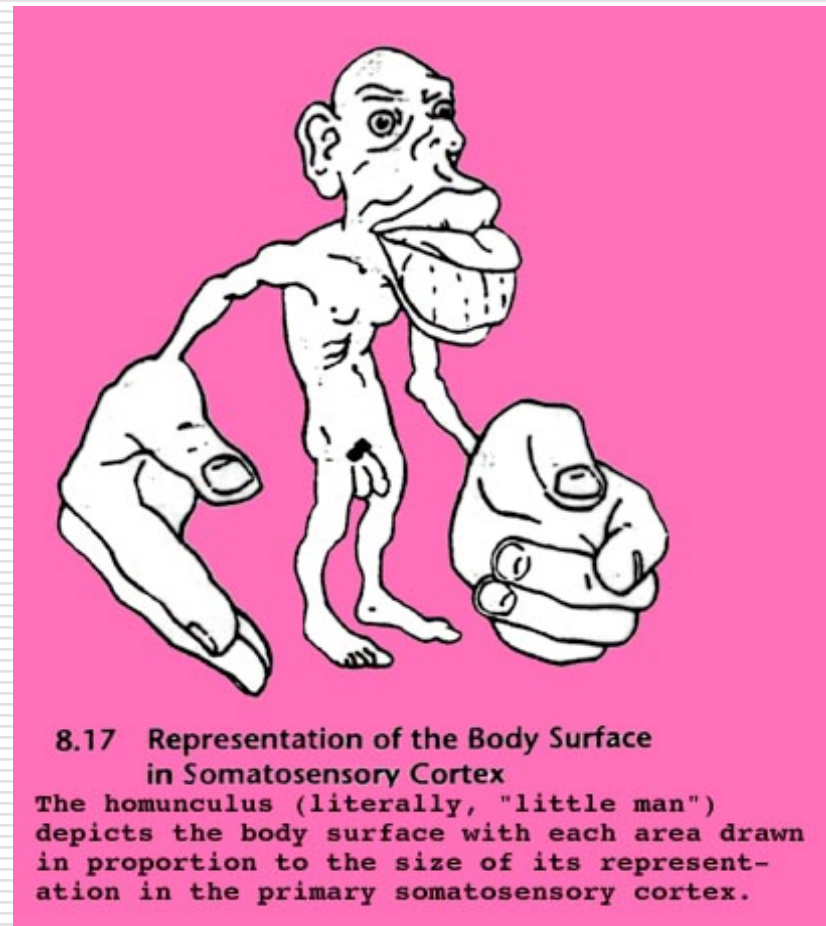
- The haptic sense is bidirectional
 - Senses the environment
 - Acts on the environment
 - Tight coupling between the two
- Skin is the largest organ

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



Haptic Sense (cont)

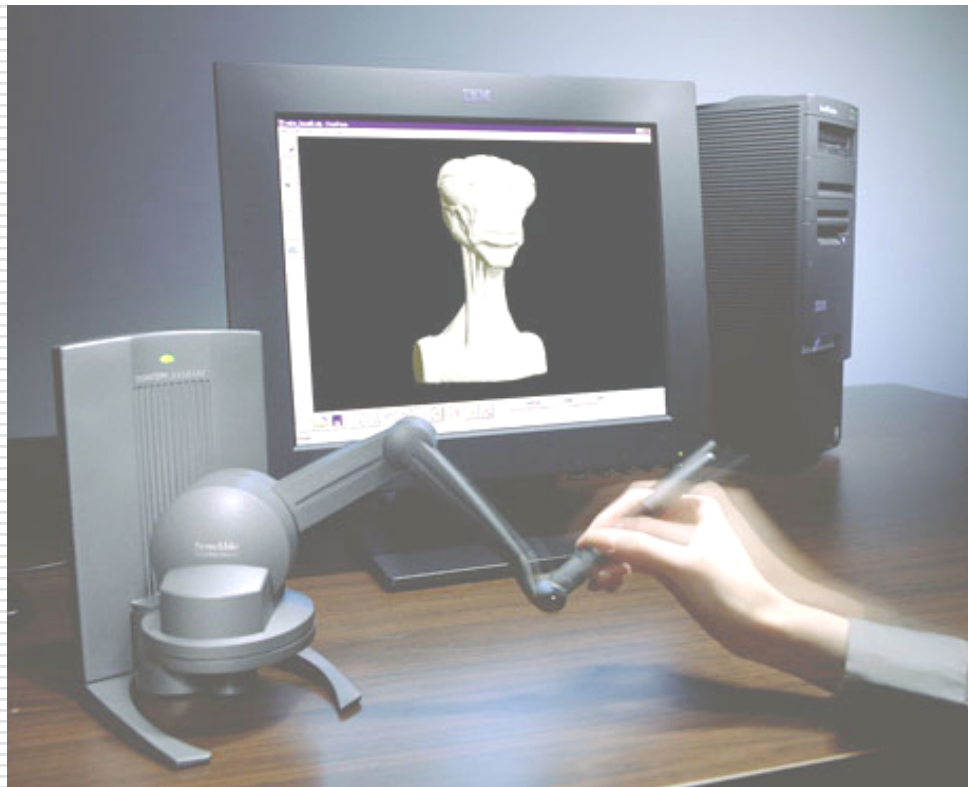
- Sensitivity varies greatly
 - Two-point discrimination



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*



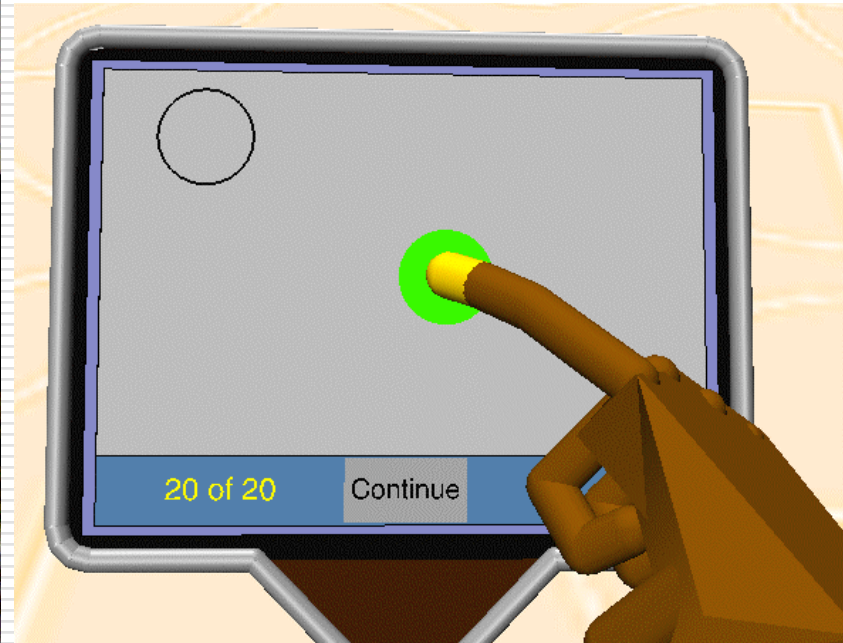
<http://www.sensable.com/>

Immersion *CyberGrasp*



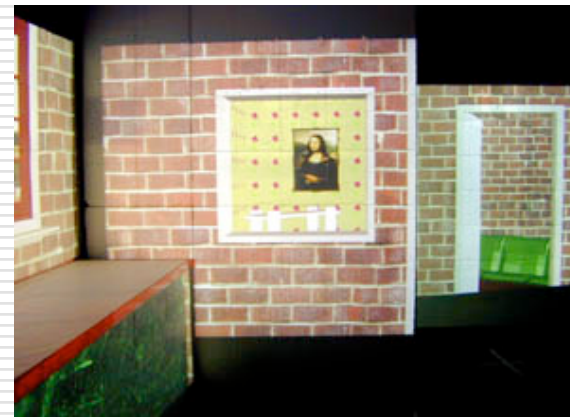
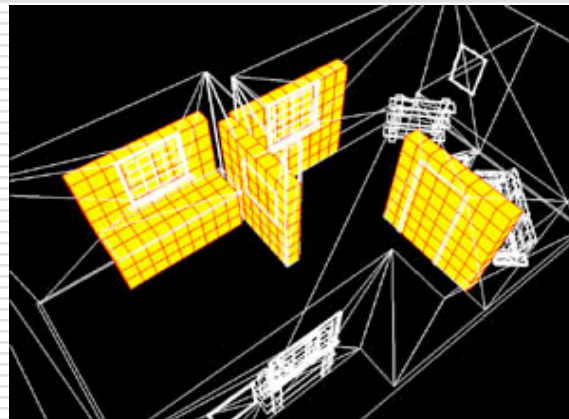
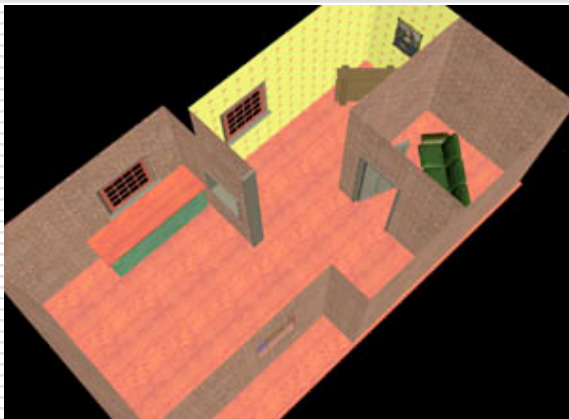
<http://www.immersion.com/>

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

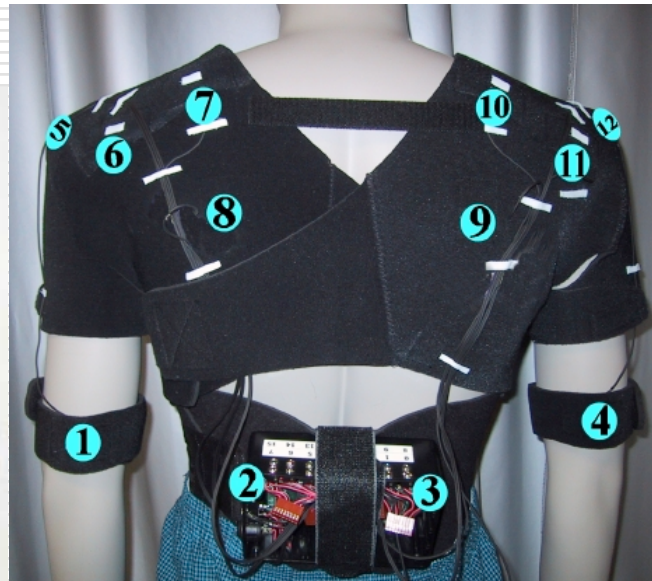
- ❑ Vibrotactile feedback has been incorporated into many devices
- ❑ Can we use this technology to provide scalable, wearable touch cues?



Vibrotactile Feedback Projects



Navy TSAS Project



**TactaBoard and
TactaVest**

