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

<table>
<thead>
<tr>
<th>Body Site</th>
<th>Threshold Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger</td>
<td>2-3mm</td>
</tr>
<tr>
<td>Cheek</td>
<td>6mm</td>
</tr>
<tr>
<td>Nose</td>
<td>7mm</td>
</tr>
<tr>
<td>Palm</td>
<td>10mm</td>
</tr>
<tr>
<td>Forehead</td>
<td>15mm</td>
</tr>
<tr>
<td>Foot</td>
<td>20mm</td>
</tr>
<tr>
<td>Belly</td>
<td>30mm</td>
</tr>
<tr>
<td>Forearm</td>
<td>35mm</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>39mm</td>
</tr>
<tr>
<td>Back</td>
<td>39mm</td>
</tr>
<tr>
<td>Shoulder</td>
<td>41mm</td>
</tr>
<tr>
<td>Thigh</td>
<td>42mm</td>
</tr>
<tr>
<td>Calf</td>
<td>45mm</td>
</tr>
</tbody>
</table>

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

http://www.sensable.com/
Immersion CyberGrasp

http://www.immersion.com/

R.W. Lindeman - WPI Dept. of Computer Science
Interactive Media & Game Development
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