

Emergent User Interfaces

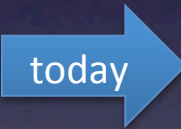
CS-E4200

Introduction to Multimodal Interaction 2

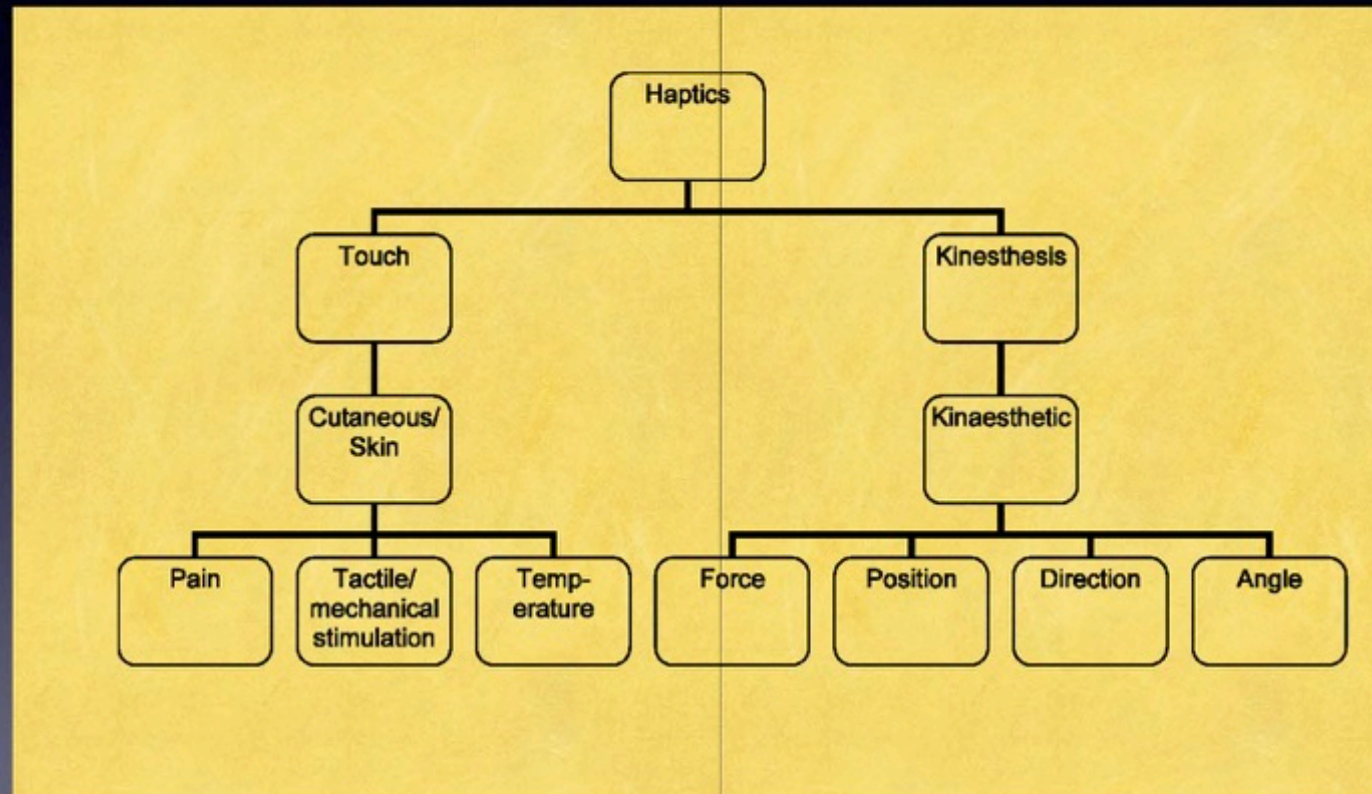
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Haptics (kinesthetics)

Haptics

- Haptics: To do with the sense of touch
- Two parts:
 -  today Kinaesthesia: Sense and motor activity based in the muscles, joints and tendons
 - Cutaneous/(touch): Sense based on receptors in the skin

Reminder



Reminder

- Cutaneous haptics occurs in the skin
- Sensed using mechanoreceptors
- Easy to exploit for mobile haptic interfaces
- Today we talk about kinaesthetic haptics

Kinaesthetic Haptics

- Also called proprioception
- Kinaesthesia: The sense that detects bodily position, weight, or movement of the muscles, tendons, and joints.
(dictionary.com)

Kinaesthesia

- Uses sensors in the limbs and joints to monitor position
- Uses sensors in the muscle to monitor applied force
- How you know hard you are pushing or not
 - e.g. Dead leg
- Also other systems (e.g. balance controlled by ear).

Proprioception/Kinaesthesia

- **Proprioception (joint position sense)**
 - Awareness of movement and positions of body parts
 - Due to nerve endings and Pacinian and Ruffini corpuscles at joints
 - Enables us to touch nose with eyes closed
 - Joints closer to body more accurately sensed
 - Users know hand position accurate to 8cm without looking at them
- **Kinaesthesia (joint movement sense)**
 - Sensing muscle contraction or stretching
 - Cutaneous mechanoreceptors measuring skin stretching
 - Helps with force sensation



Disclaimer!

- Hard to separate Cutaneous and Kinaesthesia
- One influences the other.
 - E.g. slipping or pressing
- We do it mostly because of the generation techniques, i.e. how to stimulate senses

Exploratory Procedures

LATERAL MOTION/
TEXTURE



PRESSURE/
HARDNESS



STATIC CONTACT/
TEMPERATURE



UNSUPPORTED
HOLDING/
WEIGHT



ENCLOSURE/
GLOBAL SHAPE,
VOLUME



CONTOUR FOLLOWING/
GLOBAL SHAPE,
EXACT SHAPE



Lederman & Klatzky (1987)

How do we use this?

- 2 Areas
 - Force-feedback
 - Gestural Interaction

Force Feedback

- As with Cutaneous, our ability to simulate is much lower than the haptic system is capable of detecting.
- Many Different Devices

3D Systems PHANTOM



6 degree of freedom
~\$20000
Max 22N

6 degree of freedom
~\$1000
Max 3.3N



3D Systems PHANTOM

- Like a 3D mouse and similar to cutaneous system
- Sensors in the arm detect position and movement
- Motors provide resistance
- Create the illusion of a physical object

3D Systems PHANTOM

- Program using OpenHaptics (Not Open!)
 - OpenGL like (uses OpenGL)

- e.g.

```
hlBeginShape(HL_SHAPE_FEEDBACK_BUFFER, hapticObjectIDs[i]);
  hlTouchModel(HL_CONTACT);
  hlMaterialf(HL_FRONT_AND_BACK, HL_STIFFNESS, stiffnessValue);
  hlMaterialf(HL_FRONT_AND_BACK, HL_DAMPING, dampingValue);
  hlMaterialf(HL_FRONT_AND_BACK, HL_STATIC_FRICTION, staticFrictionValue);
  hlMaterialf(HL_FRONT_AND_BACK, HL_DYNAMIC_FRICTION, dynamicFrictionValue);

  RenderVisualObject();

hlEndShape();
```

PHANTOM

- Pros:
 - Easy to implement
 - Works well with graphical interaction
- Cons:
 - Can be “squidgy”
 - Not high bandwidth & difficult to scale
 - Like poking with a stick

Novint Falcon



Similar to PHANTOM
Developed for Gaming
\$189.99
~8.89N

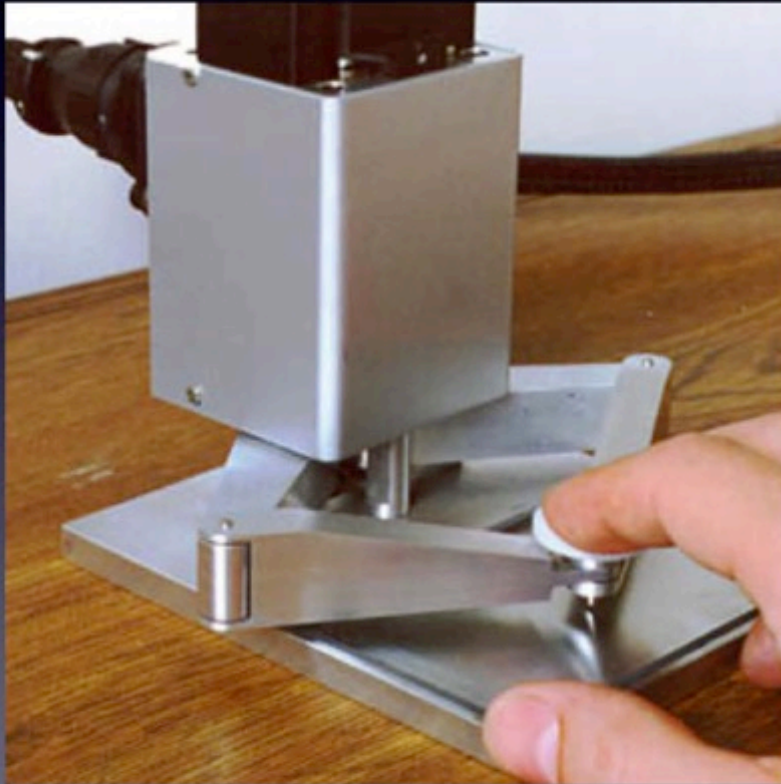
Different Design
Can be better than the PHANTOM arm
But smaller working area

Haptic Master



By Moog FCS
Very Expensive
Very High Quality
Maximum Force 250N

The Pantograph



Developed at McGill
circa 93
10 x 16 cm
workspace
2 dof
Max 10N
Also Miniaturised

Technology Conclusion

- All these ways are similar
- Motors, sensors and arms
- Vary in degrees of freedom (dof), sustainable force, maximum force, backdrive
- Not portable really
- Need space and Clunky
- Mobile Solutions?
 - Miniaturisation of joystick technology?

Other Technologies



Microsoft Sidewinder Force Feedback 2



Logitech Wingman Force Feedback Mouse

Surgical Simulation

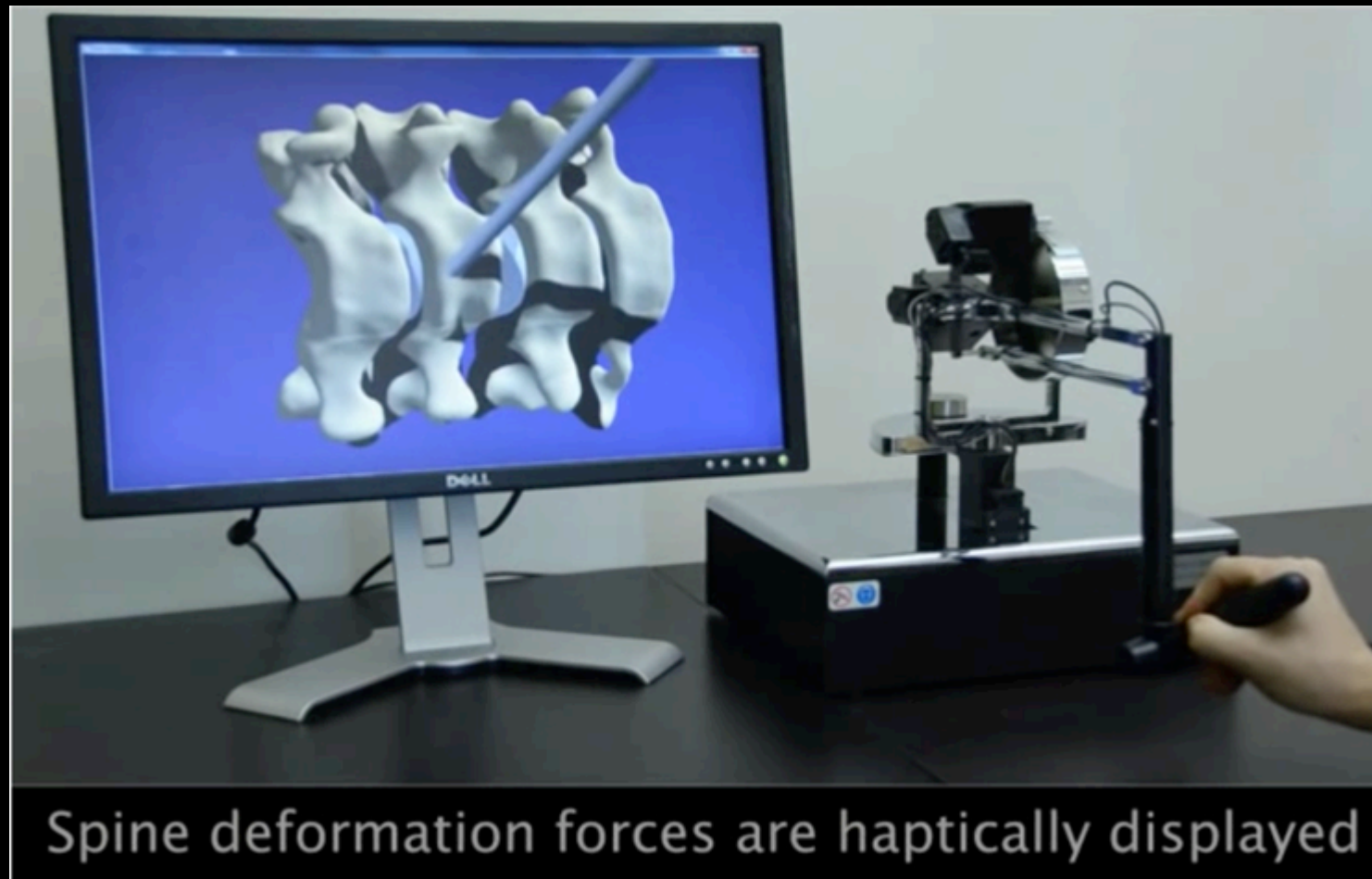
- Augmentation to RMIS (remote minimally invasive surgery)
 - Uses teleoperation to perform surgery to patients
 - Many medical benefits but loose tactile feeling of surgery
 - But not yet with haptic feedback
 - JHU looking at simulation of tissue and communicating applied force

Surgical Simulation

- Berkeley looking at a using PHANTOMS to provide feedback
- Could provide remote surgery
- Expert surgery
- Also surgical simulators and training



Surgical Simulation at GWU



<https://www.youtube.com/watch?v=c4q0TbVdSEs>