Haptic interfaces

1. Definition, scope and history
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4. Haptic design guidelines
5. Haptic interaction through virtual coupling
6. From Haptic to pseudo-haptic feedback
1. Definition, scope and history

• **Haptic**: From Greek *haptikos* (sense of touch) and *haptethai* (to touch).
  - Include both the synthesis of touch and force/torque stimuli.

• **Tactile sensors**: Surface texture, vibration, pressure, temperature, ...
  - Highest density on hand palm and finger tips.
  - Alternate tactile regions used as sensory substitution: tongue [12010]

• **Kinesthetic sensors**: Muscles, joints, tendons, ...
  - To determine the body posture and the nature of body interaction with the environment: exerted force/torque on contact locations.
1. Definition, scope and history (2)

- A haptic device IS...
  
  ... a **force reflecting device**, even at the slightest level of a mechanical vibration stimulating touch, which allows a user to feel, manipulate, create, and/or alter simulated objects in a virtual environment

  it is not sufficient to simply track movement to qualify for being a haptic system, such as magnetic or optical motion trackers.
1. Definition, scope and history (3)

• History
  
  • force feedback joystick for aircraft simulators [W]
  • in the 50s, the nuclear industry needed mechanical systems for the remote manipulation of nuclear components (Argonne USA, CEA Saclay FR).
    – Teleoperators = master / slave manipulator arm
    – The gesture performed by the user on the Master arm is reproduced on the slave arm and the force/torque reaction on the slave is felt by the user on the master arm at the level of the gripper.
    – Became electromechanical in the 60-70s.

• Early 70s: sensor substitution/neural plasticity, Bach-y-Rita [W]

• In the 90s minimally invasive medical training: laparoscopy
• Games controllers: from arcade (70s) to home
Some examples of real-world haptic systems

Master-Slave system: the collision of the slave system on a solid box is reflected on the master articulated arm. [Video](http://www.youtube.com/watch?v=iIGy6K-vjpA)

Sensory substitution on high-density sensor region (tongue) [CBS: see with tongue with brainport] [Video](http://www.youtube.com/watch?v=RaTzQVHi-C4)<br>[Video](https://www.youtube.com/watch?v=OKd56D2mvN0)
2. Haptic display characteristics [BKLP 2005]

- Haptic presentation capability
  - Tactile / kinesthetic / or both?
  - If kinesthetic: how many points of force does it provide?
  - What part of the body is it designed for (finger(s), wrist, feet,...)
  - How big/cumbersome? What is the range of motion?

- Spatial/temporal resolution
  - Touch stimulation spatial resolution must be much higher for finger tips vs forearm
  - Temporal resolution: 1000 Hz update rate is necessary for stability of the rendering of stiff contact (otherwise appear soft or unstable). Two distinct threads: haptic rendering vs visual rendering.

- Ergonomics
  - a critical requirement: Safety
  - a serious limitation: Comfort
Sensor substitution / Brainport: http://en.wikipedia.org/wiki/Paul_Bach-y-Rita

[I 2010] Blind soldier 'sees' with tongue device
http://www.youtube.com/watch?v=RaTzQVHi-C4

CBS: Blind Learn To See With Tongue
http://www.youtube.com/watch?v=OKd56D2mvN0

Master_Slave system for surgery:
http://www.youtube.com/watch?v=ilGy6K-vjpA