Haptic interfaces

video1

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

1. Definition, scope and history

- **Haptic** : [W]
  - 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 [I2010]

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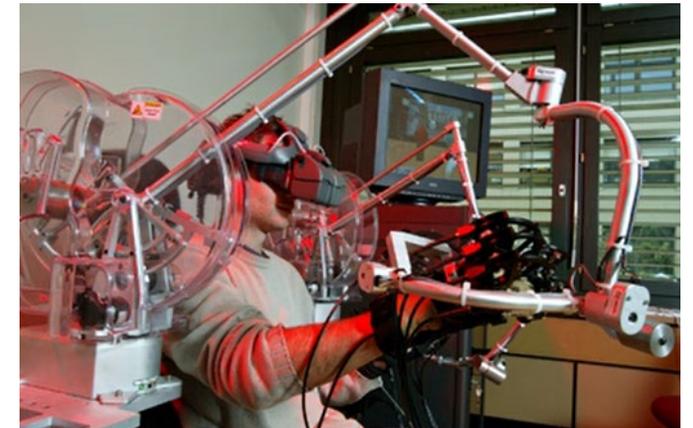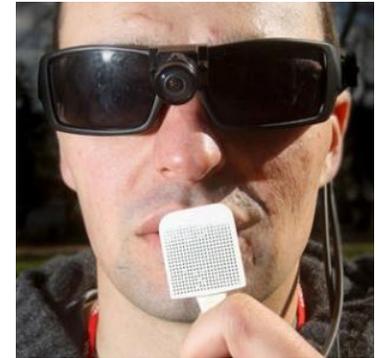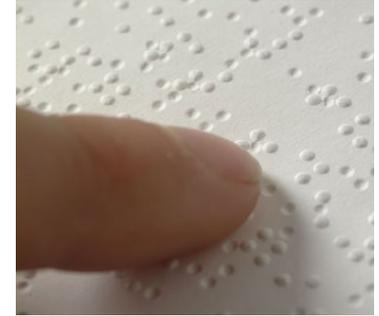
1. Definition, scope and history (2)

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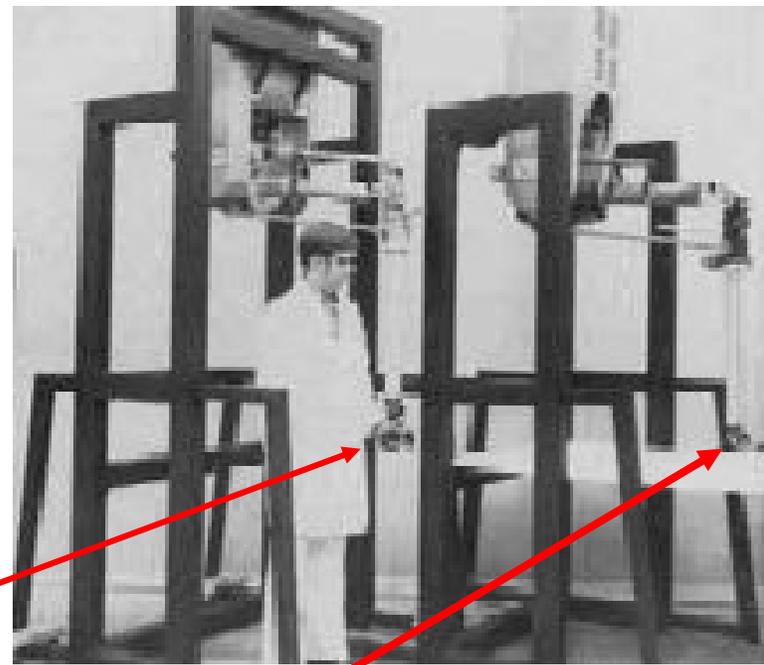
  - Early 70s: sensor substitution/neural plasticity, Bach-y-Rita [W]

  - In the 90s minimally invasive medical training : laparoscopy
  - Games controllers: from arcade (70s) to home
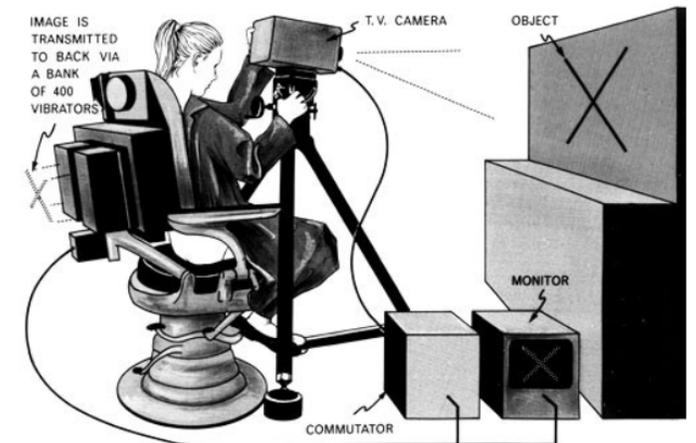
Some examples of real-world haptic systems
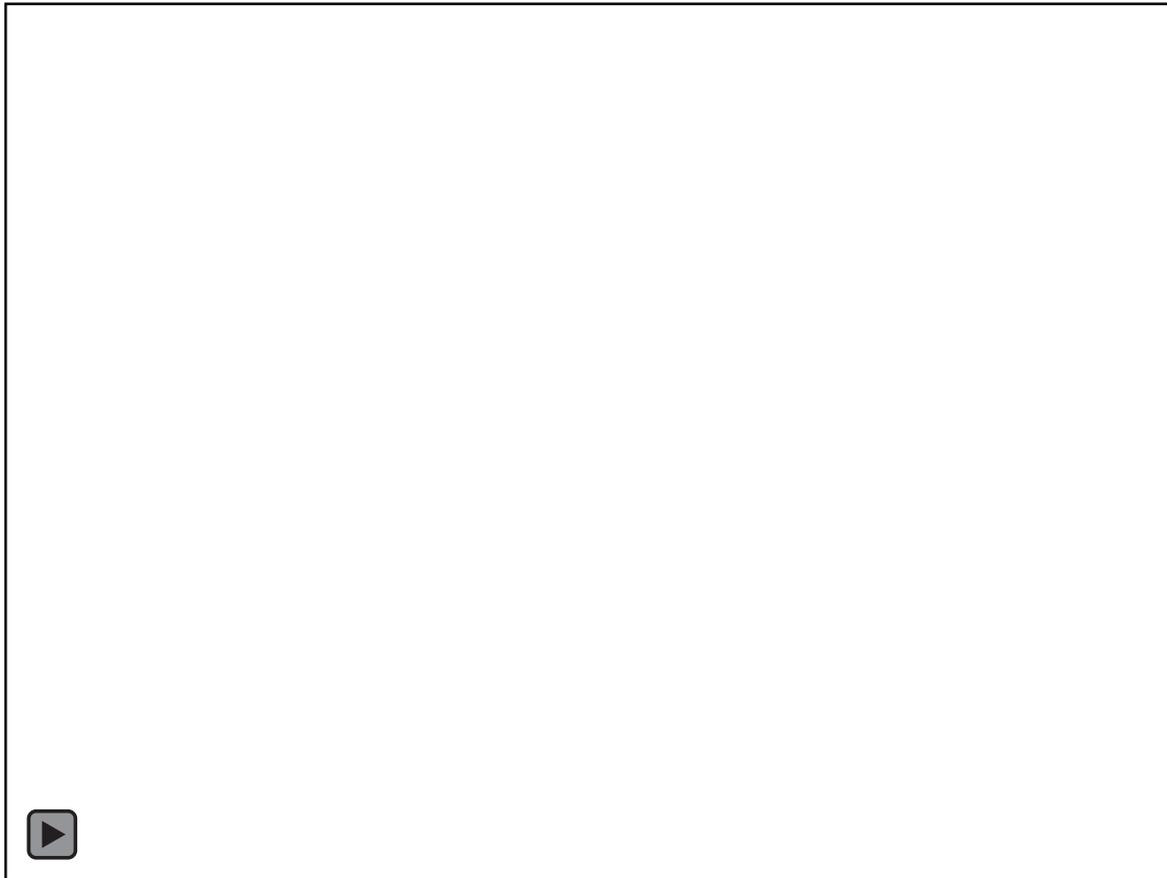
Master-Slave system : the collision of the slave system on a solid box is reflected on the master articulated arm http://www.youtube.com/watch?v=iIGy6K-vjpA

Sensory substitution on high-density sensor region (tongue)[CBS : see with tongue with brainport]

http://www.youtube.com/watch?v=RaTzQVHi-C4
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

[web References]

Sensor substitution / Brainport: http://en.wikipedia.org/wiki/Paul_Bach-y-Rita

[I 2010] Blind soldier 'sees' with tongue device

http://www.independent.co.uk/news/science/blind-soldier-sees-with-tongue-device-1921830.html

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=iIGy6K-vjpA