Arm wrestling with the robots
William Harwin
Department of Cybernetics, University of Reading.
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New actuator challenge –
Electroactive polymers, EAP

Arm wrestling a haptic interface

WAM When it comes to arm wrestling we have lost already

A brief look at haptics and haptic interfaces

Introducing haptics
Haptics in action

- Sensors in the skin and limbs
- Haptics = touch + proprioception

The theoretical bits: extending physiological proprioception

- Cutaneous
  - Temperature (heat flow)
  - Pain
  - Skin vibration (texture, slip friction)
  - Skin stretch
- Proprioceptive
  - Joint speed, muscle tension and length

Definition of haptic

- 'the sensibility of the individual to the world adjacent to his body by the use of his body' [Geldard],
- 'Haptic' comes from a Greek term meaning 'able to lay hold of'.

Bandwidth & the haptic spectrum

<table>
<thead>
<tr>
<th>Low Frequency</th>
<th>High Frequency</th>
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<tr>
<td>Shape</td>
<td>Texture</td>
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Region of Ambiguity

Exploratory procedures

- Lateral motion (texture)
- Pressure (hardness)
- Contour following (global shape)
- Unsupported holding (weight)
- Enclosure (global shape)
- Static contact (temperature)

So what are haptic interfaces

Also specific function testing (eg gloves), and self-motion tests (eg scissors)
Hapkit: First experiments in a haptic drum kit

- Feels and sounds (almost) like a real drum
- Normal drumming techniques can be applied
- Play multiple drums in the same location
- Suspend large ‘virtual’ drums upside-down, create new types of drum

Multi-modal interaction

- As a sensor, vision dominates - haptics calibrates
- Haptics are only sensory system that can be used as an interface
  - Can both touch virtual objects and manipulate them

Cheating on Perception

- Visual illusion
  - TV/monitors are just sequences of coloured dot triplets
- Need to know how to cheat
- Tactile perception of movement (Hayward comb)
- Size-weight illusion (demonstration of visual dominance)

Haptic interfaces types: Hand based

- Virtual tools
  - Person interacts with surrogate tool
- Open Hands interaction
  - Tool as well as the environment is simulated

Cube video
Haptic interfaces: body based

- Body haptics
  - Torso, tongue, chin
    - Eg piloting via vibro-tactile jacket
- Locomotion
  - Walking
  - Wheelchair simulators

Walking haptics: Exercise treadmill + robot

3D is not for wimps

- WIMP's what everyone uses to control computers
  - Windows
  - Icons
  - Menus
  - Pointers
- People work in 3 dimensions of space,
  - to put a key in a lock requires 6 variables
- Computer screens are two dimensional,
  - a mouse only controls the horizontal and vertical position
- Using a haptic device can make up to a ten fold difference in the time taken to align parts in a computer
- Wastes time on computers clicking on menus

Klein bottles/Juggling on Mars

Haptic interface applications

- User interfaces
- Art and design
- Training
- Teleoperation (telesurgery)
- Rehabilitation

Human machine interfaces

- BMW 7 series I-Drive
- Assists navigation of non driving car controls
Force feedback interfaces in computer games

Rehabilitation
- Programmable exercise machines
- Rehabilitation robots
- Assist devices
- Powered exoskeletons

Fingerspelling hand
- Based on American sign language (ASL)
- Used for people who are deaf-blind primarily due to Usher’s syndrome

Haptic Torch
- Ultrasound and haptics as a rehabilitation aid

Mr Anthony Lawton
- Walks with Cane
- 3° Tunnel Vision
- Uses very powerful hearing aids
- Found guide dog to be an unwelcome commitment
- “It’s a very comforting feeling that you can tell you are approaching something and that you have some objects coming up, brilliant.”

Video
Haptics in stroke rehabilitation

- Third leading cause of death
  - 50% of deaths in first hour
  - 30 day mortality for hemorrhagic stroke is 40%-80%
  - Survivability for ischemic stroke higher
- Leading cause of disability
- Risk factors
  - Age
  - Hypertension
  - Anticoagulant therapies
  - History of stroke
  - Cocaine abuse
  - Men have greater risk than women

Objectives of Gentle/s

- Identify specific “best practice” for robot mediated therapies
- Estimate likely cost impact on health services
- Rapid clinical prototype robot for upper extremity physiotherapies
- User feedback on rapid prototype
- Clinical evaluation
- Develop precursor commercial technologies
- Exploit results for the benefit of the European Community and its citizens.

Gentle/s therapy goals

- Focused in neuro and physical rehabilitation
- Concentrated on developing new, challenging and motivating therapies
  - Increase sensory input
  - Stimulate re-learning in the brain
  - Recover muscle strength
  - Achieve functional goals that improve independence

Clinical site, Trinity College, Dublin

Clinical site, Battle Hospital, Reading (Wheelchair accessible system)

Living pulse Video
Stroke

- A positive effect can be seen for RMT at intervention late after stroke.
- May favour more severe disabilities
- More work needed to evaluate on acute phase stroke

Other haptics applications

- Interpreting complex data
  - Eg protein molecule docking
- Teleoperation and telepresence (surgical robots)
- Virtual sculptures (can see and touch)
- Virtual clay for pottery or car design
- Medical training – virtual laproscope

The future of Haptics

- Lighter, cheaper haptic interfaces
  - Better mobile phone haptics
- Machine interfaces
  - Cars, disconnected driver
  - Computers, replacement for mouse
- Trainers and teaching
- Rehabilitation and medical
- Larger faster
  - ‘Holodeck’ haptics
  - Rapid prototyping of human controls
  - Sports training

To find out more

- On open hand haptics
  - www.cyber.rdg.ac.uk/haptics
- On haptics in rehabilitation
  - www.gentle.rdg.ac.uk
- Or insert ‘haptic interface’ into google
- This presentation is online at
  - www.reading.ac.uk/~shshawin/hapticsatventurefest.pdf

Thank you

Victor Vasarely 1906-1997
Op-Art movement
- Heet 1983

Web picture references

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