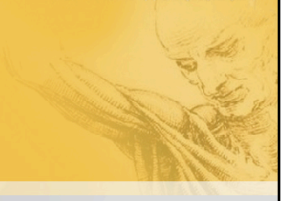


Beyond Visual: Shape, Haptics and Actuation in 3DUI

Ivan Poupyrev.

Overview

Virtual versus Real interaction

- virtual: mostly visual interaction
- real: visual, sound, smell, touch, kinesthesia

Haptics: Feeling of touch + kinesthesia

- touch: sensation resulted from stimulating human skin
- kinesthesia: sensation resulted from bodily movements and tensions

Interacting with physical objects

- perception of shapes
- perception of surface properties
- adjust and self-regulate body motion, especially 3D object manipulation
  - blind manipulation
- sense of immersion and realism
  - ability to touch = really exist

Overview

Evolutionary touch is the earliest sense developed in living organisms

Crucial to survival of species

- Fish and birds: navigation in water and air streams
- Single-cell organisms: rely only on touch to find food
- Touch is the only common feeling between a human and bacteria

Haptics – a last frontier of user interfaces

- Significantly less explored, understood and applied to UI then vision
- Exciting but challenging area of research

Overview

Two approaches to create realistic artificial environment

- Simulate every perceivable aspect of the physical environment
- Dynamically modify the physical world itself to communicate information
  - Ivan Sutherland "Ultimate Display"

Shape displays and actuated interfaces

- Influenced by robotics, haptics and tangible UI research
- Presenting 3D information by directly reconfiguring physical environment

"Source"

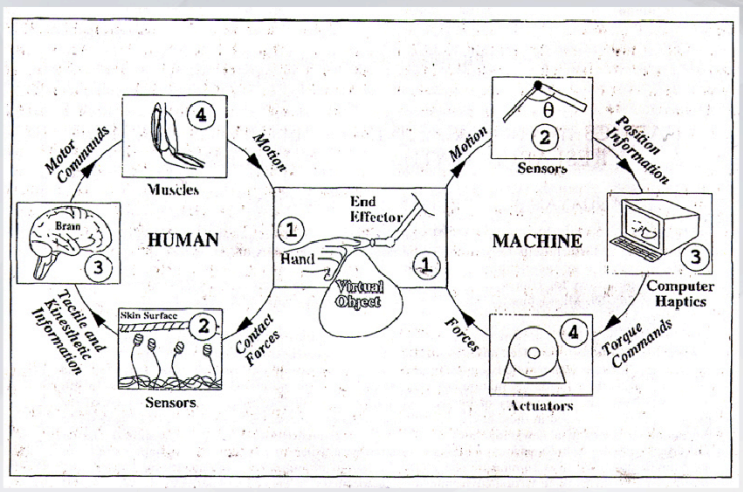
Overview

This lecture will overview

1. Interfaces that produce feeling of interacting with 3D physical objects by simulating sense of touch
   1. Force feedback devices
   2. Tactile user interfaces
2. Interfaces that use physical actuation and physical re-configurability to communicate information to the user
3. Discussed in relation to 3D interfaces and spatial interaction

Haptic interfaces

Haptic interaction between human and machine (from Srinivasan, et al. 1997)



Haptic Interfaces

Two classes of haptic displays

- Tactile displays
  - The direct touch and feel of 3D virtual objects contacting the skin is simulated
- Net force displays
  - The interaction with 3D objects is simulated through the tool.
- Can be used in combination

Haptic interfaces

Net force displays

- has been extensively developed and relatively successful
  - requires net just single force and net torque computed
  - product released e.g. Phantom by Senseble
- response matches some of the basic properties of human sensor-motor performance

Underlying technology

- motors, pneumatic actuators, magnetic break particles

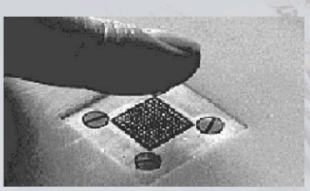
Haptic interfaces

Tactile displays

- a challenging area of research
- requires a display that can distribute forces and torques on the skin over the area of touch
  - single point tactile simulation are often presented with vibrotactile feedback
  - multipoint simulation can be achieved using actuator arrays

Underlying technologies

- piezo-actuators, SMA, micro-motors



Haptic displays

Applications of haptic displays in 3D UI

- simulation of objects physical properties, e.g. stiffness, weight
  - application in medical simulators
- simulation of surface properties, e.g. texture, roughness, etc.
- guiding the user through haptic feedback
  - e.g. desktop haptics
- Alerting, simulation of impact
  - e.g. games

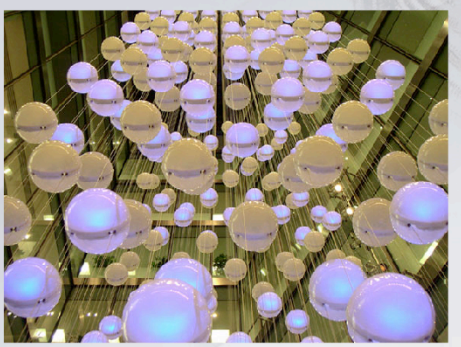
Effect on user performance

- Faster and more precise manipulation
- Immersion and higher believability

Shape and actuated displays

Direct shape creation and interaction through physical motion of the device

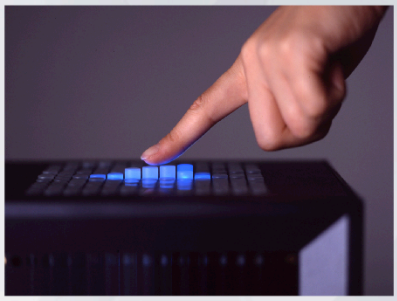
- creating 3D structures dynamically
- creating 3D relief structures with or without visual overlay
  - different scales from building to hand-held device
  - touchable and not touchable
- creating creature-like structures
  - entertainment robots



Source by Greyworld

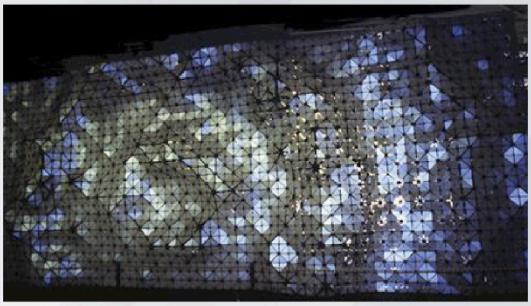
Shape and actuated displays

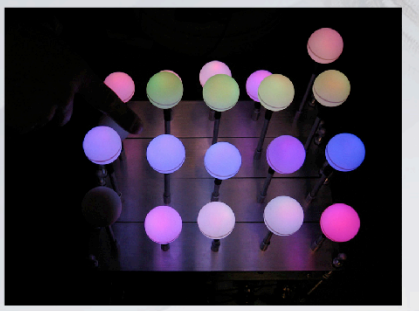
Lumen by Poupyrev
Snoil by Frey



Shape and actuated displays

Aegis Hyposyrface
Glowbits





Shape and actuated displays

Outerspace

Conclusions

3D interaction is more then visual information, its also force and tactile feedback and tactile feedback

- improve understanding and interaction with 3D virtual environments
- Increase, realism, immersion and enjoyment

The physicality of interaction can be achieved by two different means

- simulating forces and sensations communicated to the user
- create actuated physical devices that directly simulate some properties of the virtual world
  - shape displays can be considered very primitive “Ultimate Display”

Current research barely scratches the surface more interesting work is going to appear