CSE 165: 3D User Interaction

Lecture #15: 3D UI Design

Announcements

- Blog update #2 due Sunday night
  - Need more than just screen shots – see project description
- Final project video due 3/22 at 2pm
- Final project presentations on March 22
  - 3-4pm: videos in 1242
  - 4-5pm: demos part 1
  - 5-6pm: demos part 2

3D UI Design Strategies

Thus far…

- We covered universal 3D UI tasks
  - Selection
  - Manipulation
  - Navigation
  - System control
  - Symbolic input

But: The combination of techniques and devices alone does not guarantee an **enjoyable** 3D UI experience!

3D UI Design – Designing for Humans

- Microlevel: implementation
  - 3D interaction programming: hard!
  - Testing: difficult and hard to automate
  - Tweaking UI parameters: important but time consuming
- Macrolevel: guidelines
  - Strengths and limitations of human psychology/physiology
  - Common sense
    - Example: people naturally use 2 hands, so using 2 hands in a 3D UI might improve usability/performance

Designing for Humans - Feedback

- Feedback is critical to usable 3D interfaces
  - User feedback is any information conveyed to the user to help understand
    - system state
    - result of operation
    - status of task
- **Feedback control** mechanism
  - Example: turning a knob produces feedback by
    - external sources: the knob
    - internal sources: user's body
- Want to have appropriate **feedback levels**
- Ensure **compliance** (agreement) between different levels/types of feedback

Designing for Humans – Compliance

- **Compliance** is the main principle in design feedback
- Want different feedback dimensions to be **synchronized**
  - Maintain spatial and temporal correspondence between multiple feedback dimensions
- **Feedback displacement** is to be avoided
  - Example: hand and virtual object move in different directions

Designing for Humans – Spatial Compliance

- **Directional compliance** – virtual object should move in the same direction as manipulated by input device
- **Nulling compliance** – when user returns device to initial pose, virtual object returns to corresponding initial pose
- Instrumental and operational feedback also require **spatial compliance**
  - Example: real and virtual hand should be aligned

Designing for Humans – Temporal Compliance

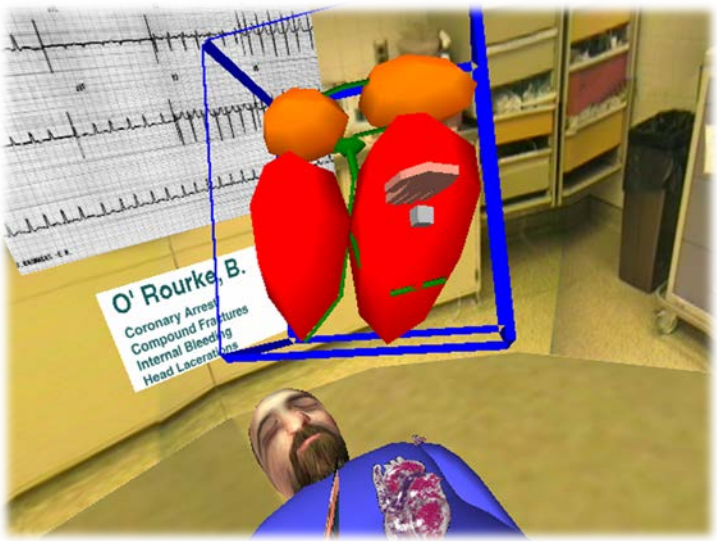
- Latency – typical problem
  - Temporal delay between user input and sensory feedback
- Variable latency can be even more problematic
- Solutions?
  - Reduce scene complexity
  - Faster hardware
  - Predictive tracking

Designing for Humans – Feedback in Multiple Dimensions

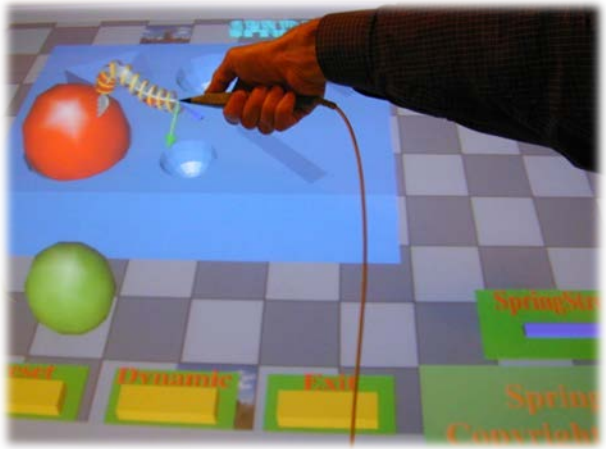
- Sensory dimensions
  - Visual, auditory, tactile, olfactory
  - Proprioceptive: position relative to the body
  - Kinesthetic: bodily motion
- Want to try to give **multi-dimensional** feedback
  - Can be difficult due to technology limitations (eg, haptic feedback still in early stages)
  - Sensory **feedback substitution**
    - Example: visual/audio cues compensate for missing haptic feedback

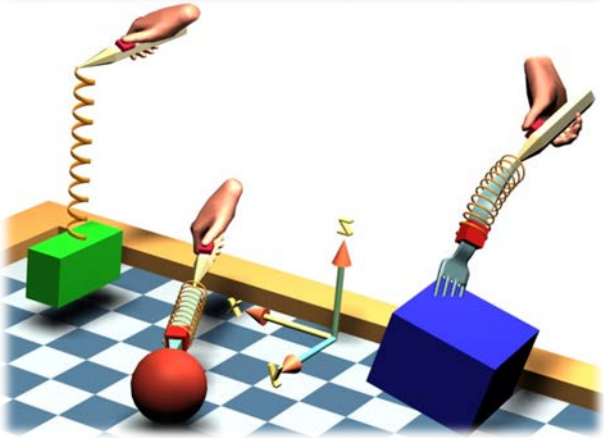
Designing for Humans – Feedback Substitution

- Cannot always support all sensory feedback dimensions
- Typical approach is to substitute



Highlighting object about to be selected





Spring Manipulation Tools, Michal Koutek, TU Delft

Designing for Humans – Passive Haptics

- Match shape and appearance of virtual object with physical prop
  - User both sees and feels
- Advantage
  - Inexpensive haptic/tactile feedback
- Disadvantage
  - Scalability: all users need physical prop

Designing for Humans – Constraints

- Constraints:
  - Are a relation between variables that must be satisfied
    - Example: a line should stay horizontal
  - Define geometrical coherence of scene
  - Can make interaction simpler and improve accuracy

Designing for Humans – Constraint Types

- Physically realistic constraints
  - Collision detection and avoidance
  - Gravity
- DOF reduction
  - Simplify interaction (example: constrain travel to ground)
- Dynamic alignment tools
  - Grids and snapping, guiding surfaces
- Intelligent constraints
  - Example: lamp can only stand on horizontal surfaces

Designing for Humans – Two Handed Control

- A.k.a. bimanual input
- Transfer everyday manipulation experiences to 3D UI
- Can increase user performance on certain tasks

Designing for Humans – Guiard's Framework

- Tasks are
  - Unimanual: throwing darts
  - Bimanual symmetric
    - Synchronous: pulling a rope
    - Asynchronous: typing on keyboard
  - Bimanual asymmetric (cooperative): holding a cell phone with one hand, operating it with the other
- Division of labor (hand roles) for asymmetric scenario:
  - Nondominant hand dynamically adjusts spatial frame of reference for dominant hand
  - Dominant hand produces precision movements, nondominant hand performs gross manipulation

Designing for Different User Groups

- Age
- Prior 3D UI experience
- Physical characteristics: arm length, etc.
- Perceptual, cognitive, motor capabilities
  - Color recognition
  - Stereo vision
  - Spatial abilities

Designing for User Comfort

- Weight of equipment
- Keep users in proper physical space
- Hygiene and public installations
- Keep sessions short (30-45min max) to prevent sickness, fatigue

3D UIs of the Future

Discussion Topics

- What is feasible today?
  - How could you implement it?
    - Hardware
    - Algorithms
- What is not feasible today but probably will be soon?
- What may never be feasible?

Iron Man 2

- https://www.youtube.com/watch?v=YAXsZphpiu8

A Day Made of Glass 2017

- https://www.youtube.com/watch?v=4UX0tGiWiYg

Microsoft's Concept of 2019

- http://www.youtube.com/watch?v=bwj2s_5e12U