CSE 165: 3D User Interaction

Lecture #4:
Selection Techniques

Announcements

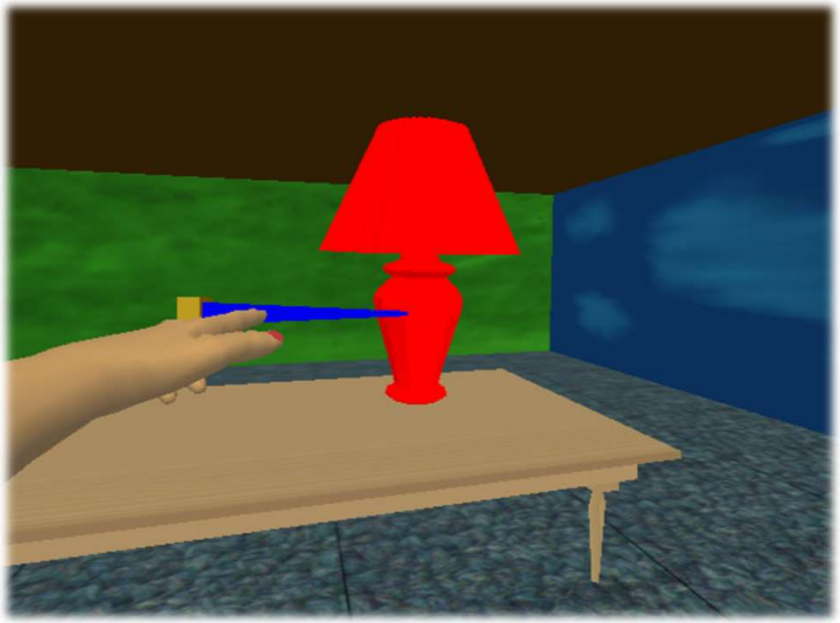
- Sign up for video presentation
  - Deadline: Sunday, Jan 17, 11:59pm
  - Pick a date now – choose video later
- Homework Assignment 1 is due Sunday, Jan 24 at 11:59pm
- Late deadline: Jan 31 at 11:59pm

3D UI Presentations

- Jason Lin
- Kaiyuan Hu:
  HoloLens2 AR Headset: On Stage Live Demonstration

Ray-Casting

- User points at objects with virtual ray
- Ray defines and visualizes pointing direction
- First intersected object is selected



$$\mathbf{p}(\alpha) = \mathbf{h} + \alpha \cdot \vec{\mathbf{p}}$$

$$\mathbf{h} = 3\text{D position of virtual hand}$$

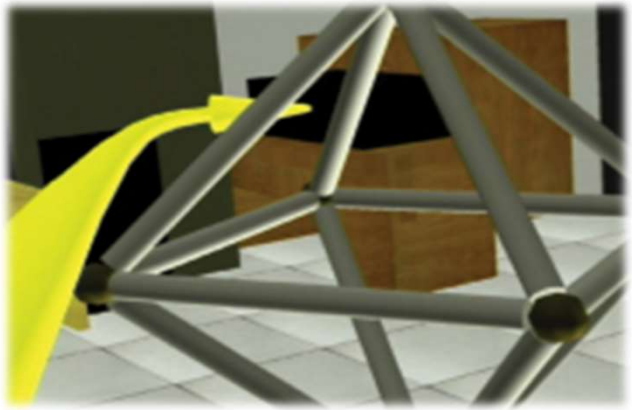
$$\vec{\mathbf{p}} = \text{ray attached to } \mathbf{h}$$

$$0 < \alpha < \infty \text{ determined by first object intersection}$$

Selection with Raycasts in Unity

Two-Handed Pointing

- Ray casting with 2 hands
- More control
  - Distance between hands controls length
  - Allows pointing at things behind other things



$$\mathbf{p}(\alpha) = \mathbf{h}_\mathbf{l} + \alpha \cdot (\mathbf{h}_\mathbf{r} - \mathbf{h}_\mathbf{l})$$

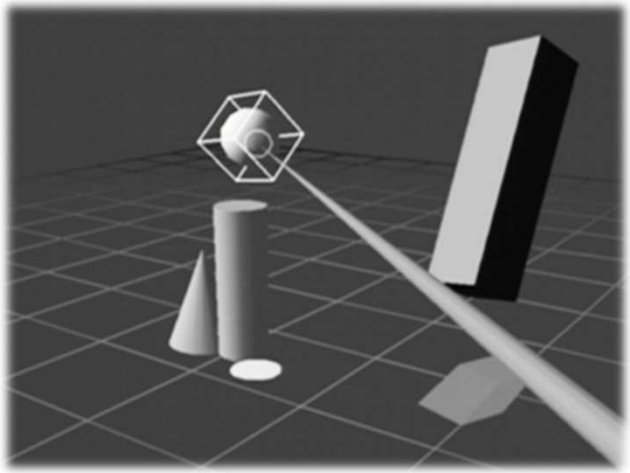
$$0 < \alpha < \infty \text{ is fixed}$$

$$\mathbf{h}_\mathbf{l} = \text{3D position of left hand}$$

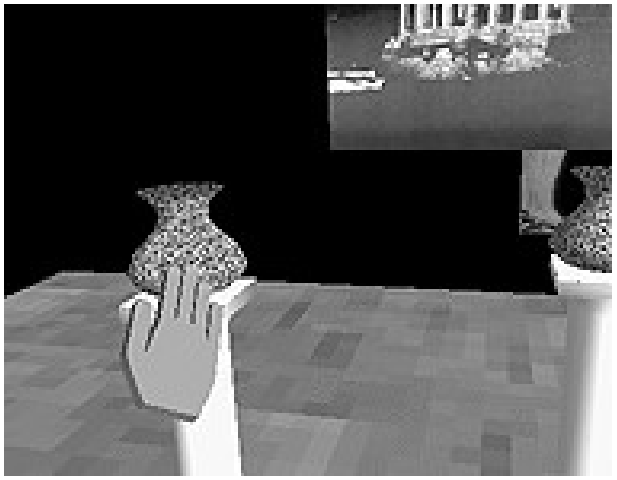
$$\mathbf{h}_\mathbf{r} = \text{3D position of right hand}$$

Flashlight

- Does not need precision
- Conic selection volume
  - Tip of cone in wand
  - Cone direction determined by wand direction
  - Fixed cone size
- If multiple objects in cone
  - Object closer to center line of cone is selected
  - If multiple objects are equally close to center line: select object closer to device



Virtual Hand



- Select and manipulate directly with hand
- Hand represented as 3D cursor
- Intersection between cursor and object indicates selection

$$\mathbf{p}_v = \alpha \cdot \mathbf{p}_r, \mathbf{R}_v = \mathbf{R}_r$$

$$\mathbf{p}_r, \mathbf{R}_r = \text{position and orientation of real hand}$$

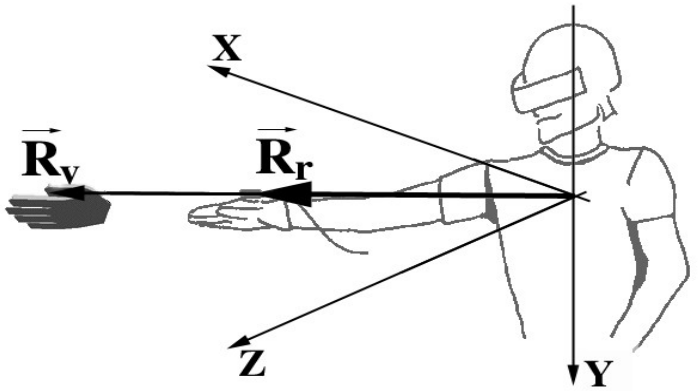
$$\mathbf{p}_v, \mathbf{R}_v = \text{position and orientation of hand in VE}$$

$$\alpha = \text{fixed scaling factor}$$

Hand-Object Interaction

Go-Go

- By Ivan Poupyrev, 1996
- Arm-extension technique
- Touch objects to select, like simple virtual hand
- Non-linear mapping between physical and virtual hand position
- Requires torso position
- Local and distant regions

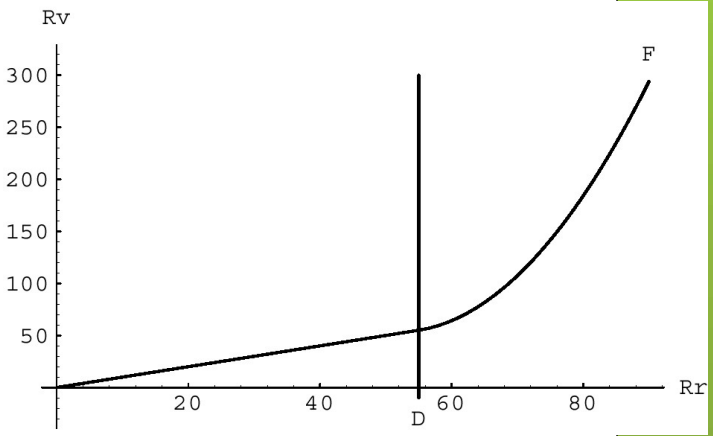


$$r_v = F(r_r) = \begin{cases} r_r & if\ r_r \le D \\ r_r + \alpha(r_r - D)^2 & otherwise \end{cases}$$

where r_r = length of $\vec{\mathbf{R}}_\mathbf{r}$

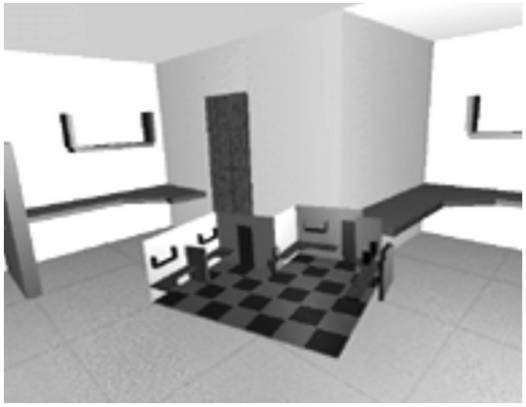
r_v = length of $\vec{\mathbf{R}}_\mathbf{v}$

D, α are constants



World-in-Miniature (WIM)

- By Stoakley, 1995
- "Dollhouse" world held in user's hand
- Miniature objects can be manipulated directly
- Moving miniature objects affects full-scale objects
- Can also be used for navigation



World-in-Miniature Demo

Voodoo Doll

- Pierce et al. 1999
- Two-handed technique
- Builds upon image plane and WIM techniques
- Developed for pinch gloves
  - Requires finger pose tracking
- Creates copies of objects (dolls) for manipulation
- Non-dominant hand: stationary frame of reference
- Dominant hand: defines position and orientation

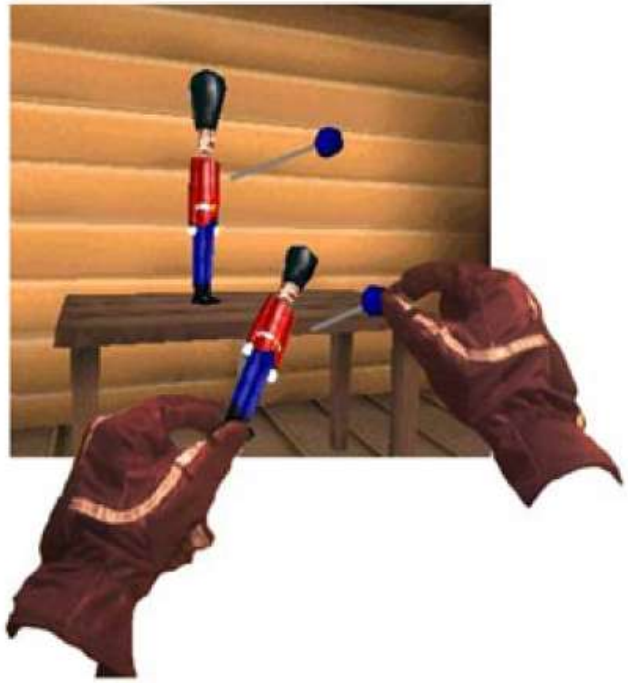
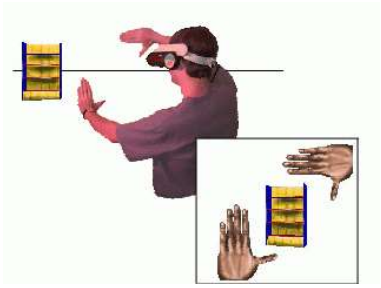


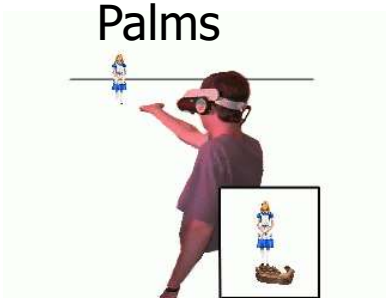
Image Plane Techniques

- Require only 2 DOF
  - Selection based on 2D projections
  - Use virtual image plane in front of user
    - Dependent on head/eye position

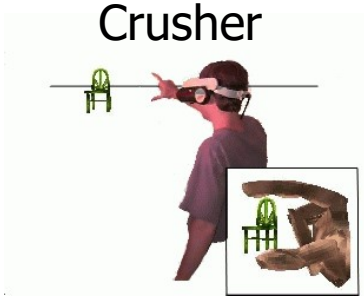
Framing



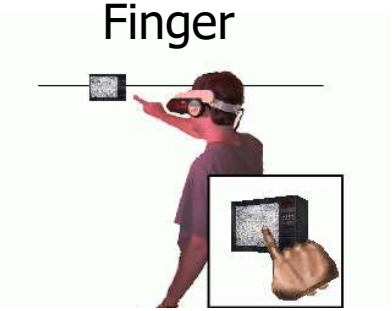
Lifting Palms



Head-Crusher



Sticky Finger



Forced Perspective

- Used in game Superliminal
  - Released Dec 2019
  - Tech demo video:

Development steps for new interaction concept

- Ecxample:
  Summoning and Superpowers: Designing VR Interactions at a Distance
  - http://blog.leapmotion.com/summoning-superpowers-designing-vr-interactions-distance/

Technique Classification by Metaphor

- Manipulation techniques
  - Egocentric metaphor
    - Virtual pointer metaphor
      - Ray-casting
      - Two-handed pointing
      - Flashlight
      - Image plane
      - Forced Perspective
    - Direct manipulation
      - "Classical" virtual hand
      - Go-Go
  - Exocentric metaphor
    - World-in-miniature
  - Hybrid techniques
    - Voodoo Dolls