CSE190 3DUI
- Winter 2013

CSE 190:
3D User
Interaction

Lecture #7: Selection

Jürgen P. Schulze, Ph.D.

Announcements

- Homework assignment #2 due Friday, February 8th at 1pm in Sequoia lab 142
  - This time grading starts at 12 noon
- Reminder: recommended reading

Augmented Reality Demo

- Web app: http://www.nature.com/naturejobs/science/profiles/kaust-ar

Razer Hydra

- Developed by Sixense Entertainment
- Released June 16, 2011
- Tracks absolute position and orientation (6 DOF)
  - Precision: 1mm and 1 degree
- Uses a weak electro-magnetic field
- Two wired input devices

4

Razer Hydra Video

- Razer Hydra for low-cost 3D displays
  - By Oliver Kreylos, UCD
  - http://www.youtube.com/watch?v=H5bSz VByLjM
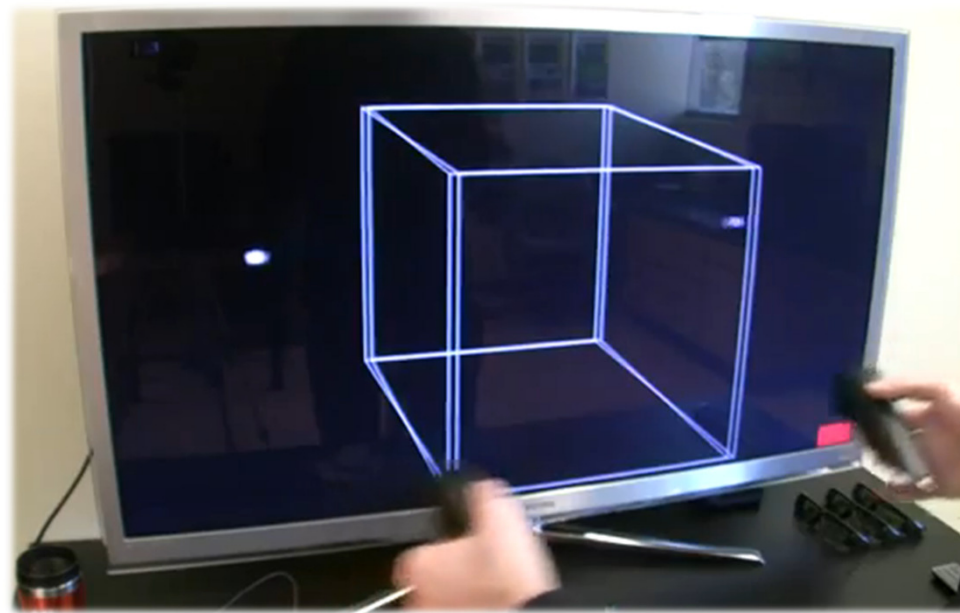
Leap Motion

- Short range finger tracking
  - To date no access to depth map
- Inexpensive ($70 on pre-order)
- Not yet available (promised for early 2014)
- SDK available today
- Developer units being shipped
- More and more demo videos available

CPU   LEDs   Sensors

Leap Video

- https://www.leapmotion.com/
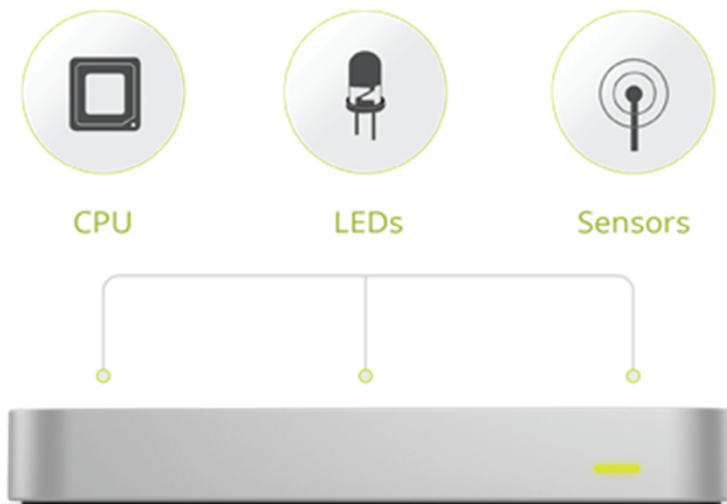
Why Selection and Manipulation?

- Major method of interaction with physical environments

- Major method of interaction with virtual environments

- Affects the quality of entire 3D interface

- Design of 3D manipulation techniques is difficult

Selection & Manipulation

- Selection: specifying one or more objects from a set

- Manipulation: modifying object properties (position, orientation, scale, shape, color, texture, behavior, etc.)

Goals of Selection

- Indicate action on object
- Query object
- Make object active
- Travel to object location
- Set up manipulation

Selection Performance

- Variables affecting user performance
  - Object distance from user
  - Object size
  - Density of objects in area
  - Presence of occluding objects

Canonical Parameters

- Selection
  - distance and direction to target
  - target size
  - density of objects around the target
  - number of targets to be selected
  - target occlusion
- Positioning
  - distance/direction to initial position
  - distance/direction to target position
  - translation distance
  - required precision of positioning
- Rotation
  - distance to target
  - initial orientation
  - final orientation
  - amount of rotation

Input Device Parameters

- Number of control dimensions
- Control integration: how many DOF are controlled simultaneously
- Force vs. position control
- Form factor: impact on accuracy

Sensor attached to hand

Sensor rolled with fingers

Technique Classification by Metaphor

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

Isomorphic vs. Non-Isomorphic View

- Isomorphic
  - Geometrical on-to-one correspondence between hand motions in physical and virtual worlds
  - Natural interactions
- Non-Isomorphic
  - "Magic" virtual tools (laser beams, rubber arms, etc.)

Ray-Casting

- User points at objects with virtual ray
- Ray defines and visualizes pointing direction
- First intersected object is selected
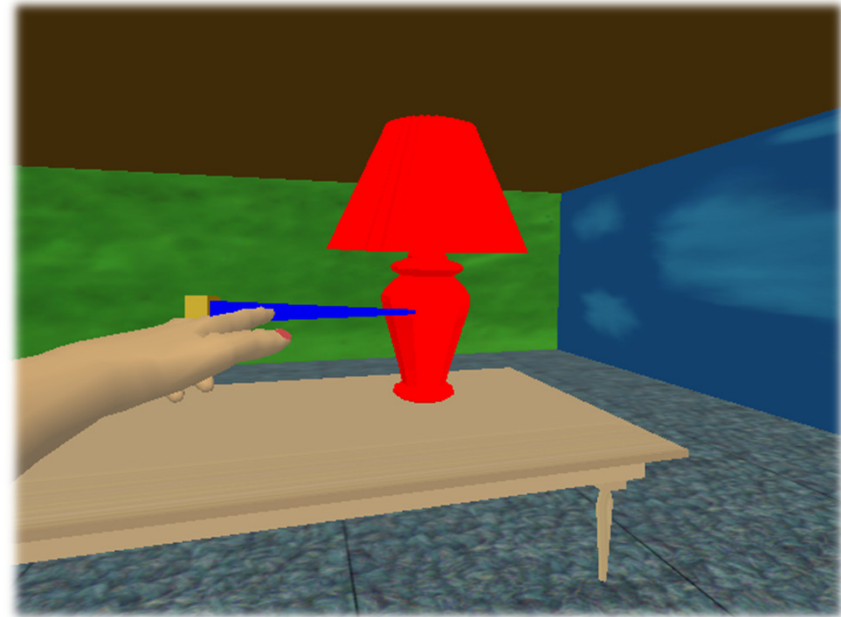
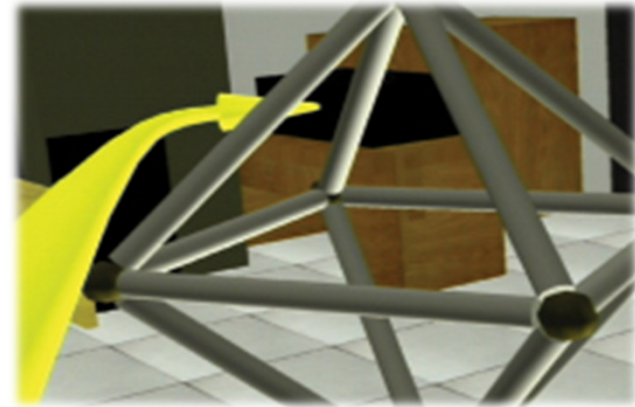$$\mathbf{p}(\alpha) = \mathbf{h} + \alpha \cdot \vec{\mathbf{p}}$$

where $0 < \alpha < \infty$, determined by first object intersection

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

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

Two-Handed Pointing

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

$$\mathbf{p}(\alpha) = \mathbf{h_l} + \alpha \cdot (\mathbf{h_r} - \mathbf{h_l})$$

where $0 < \alpha < \infty$, fixed parameter

$\mathbf{h_l} = $ 3D position of left hand

$\mathbf{h_r} = $ 3D position of right hand

Flashlight

- Soft selection technique
  - 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
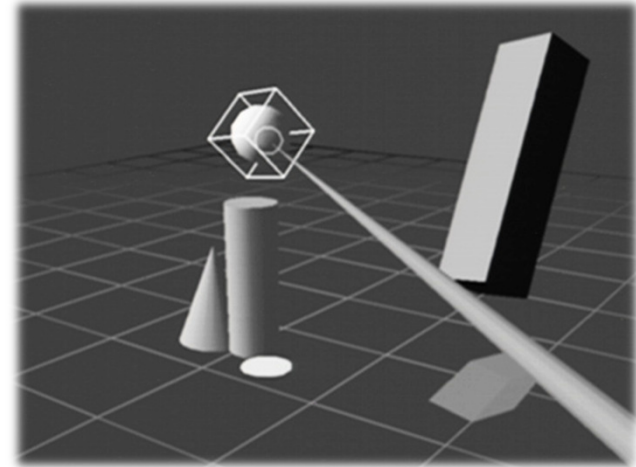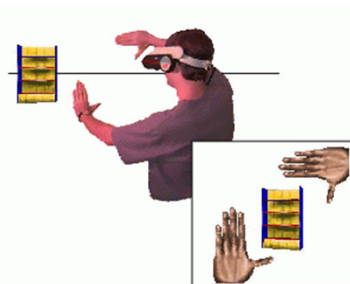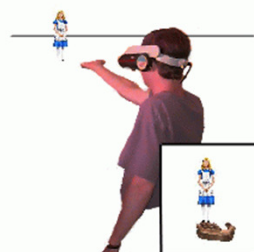
Image Plane Techniques

- Require only 2 DOF
  - Selection based on 2D projections
  - Use virtual image plane in front of user
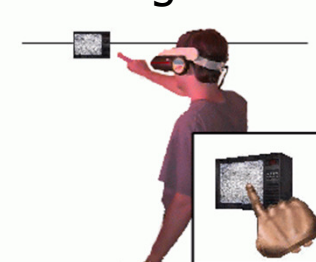   - Dependent on head/eye position
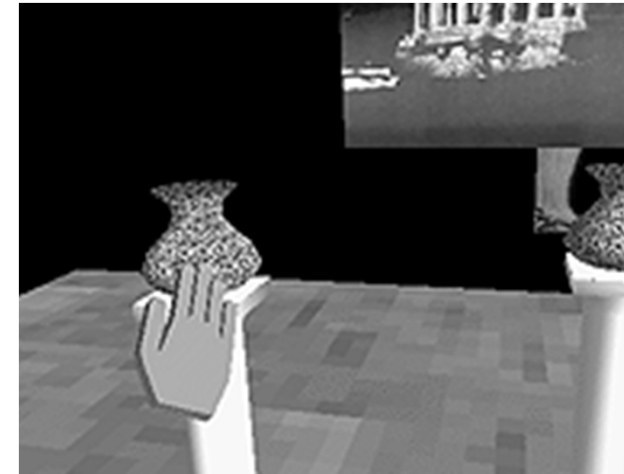
Framing	Lifting Palms	Head-Crusher	Sticky Finger
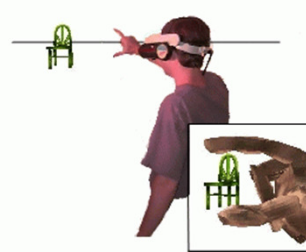
Virtual Hand

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

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

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

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

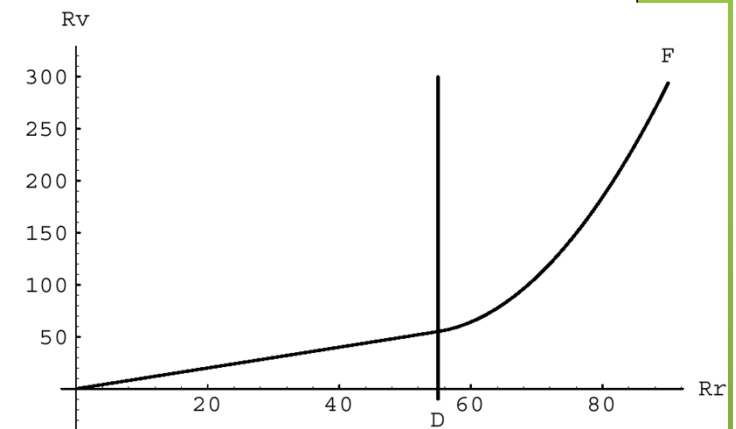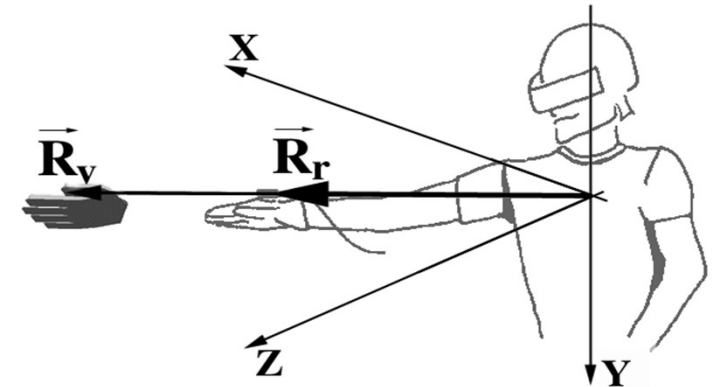$\alpha =$ fixed scaling factor

Go-Go

- By 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

$$r_v = F(r_r) = \begin{cases} r_r & if\, r_r \le D \\ r_r + \alpha(r_r - D)^2 & otherwise \end{cases}$$
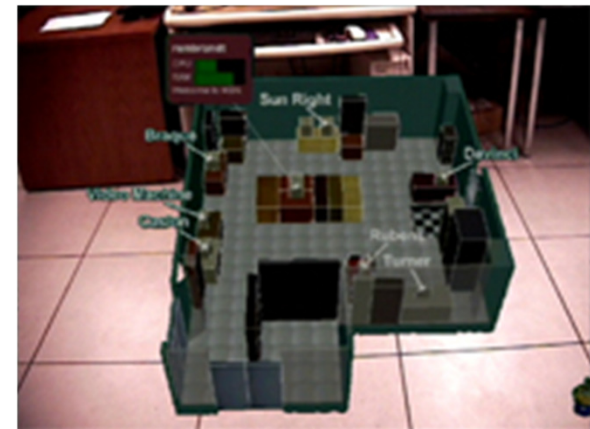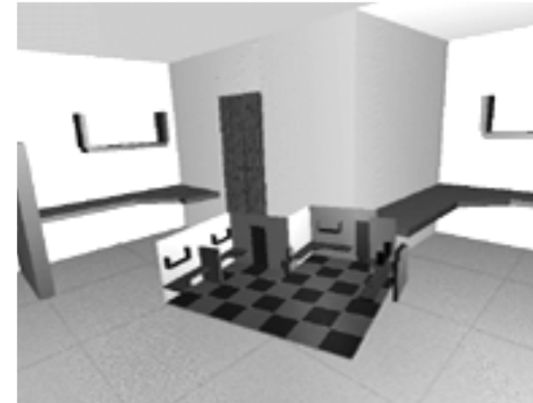
where $r_r = $ length of $\vec{\mathbf{R}}_\mathbf{r}$

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

D, α are constants


21

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

HOMER

Hand-Centered
Object
Manipulation
Extending
Ray-Casting

- By Bowman/Hodges, 1997
- Select: ray-casting
- Manipulate: hand-centered

Time

1.0 m

0.3 m

torso physical
hand

2.0 m

0.6 m

torso physical
hand
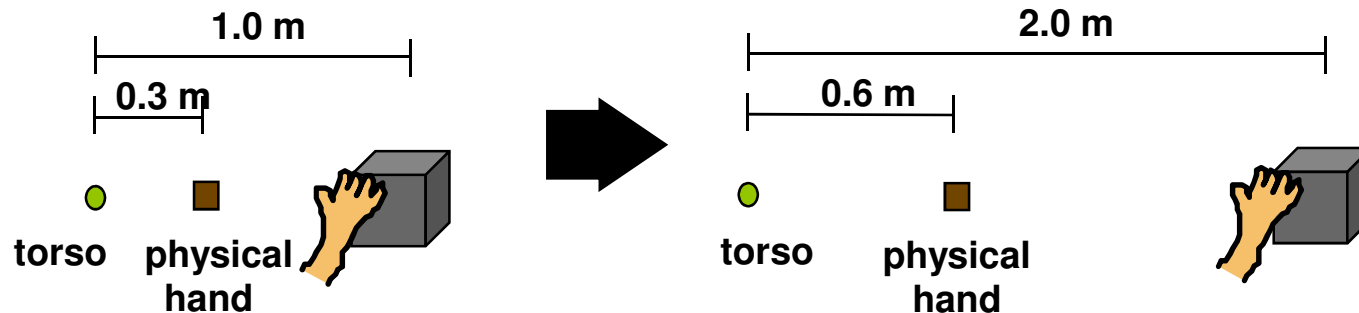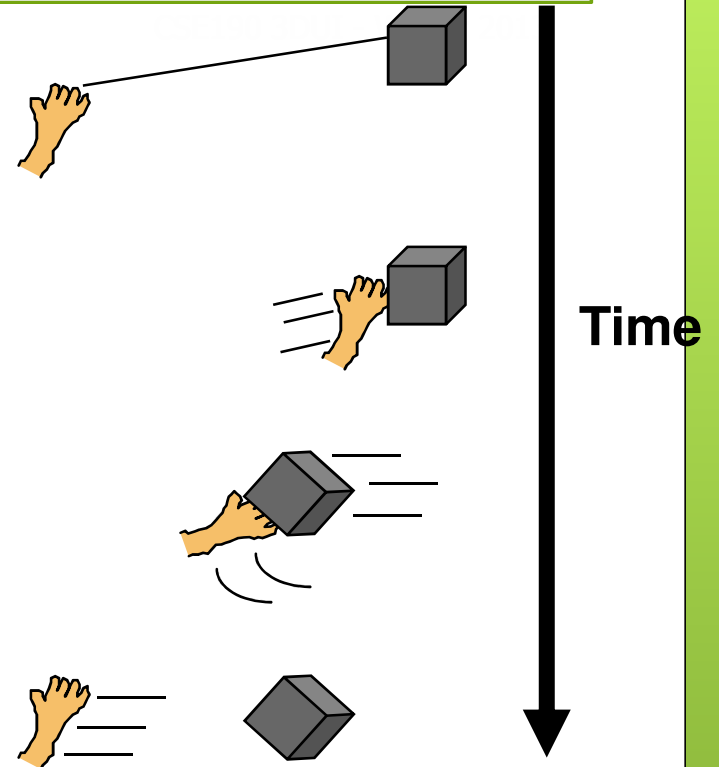
Scaled-World Grab

- By Mine et al., 1997
- Often used with occlusion
- At selection, scale world down so that virtual hand touches selected object
- User initially does not notice a change in the image
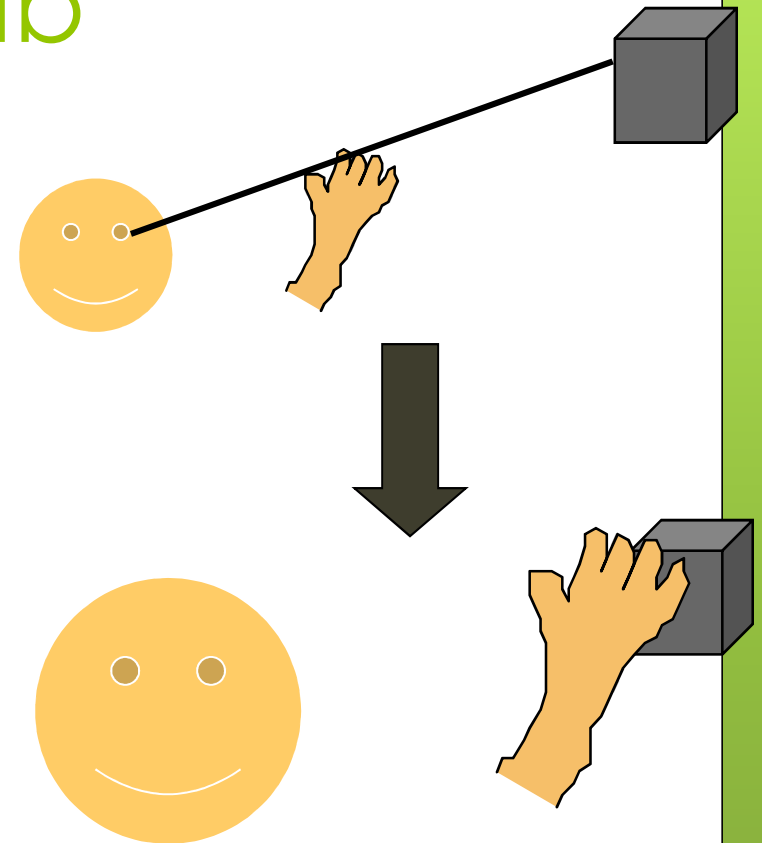
Voodoo Dolls

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