Interaction

in 3D and 2D

Interaction in the (near) future?

- For science and humanity:

  - http://www.youtube.com/watch?v=uKeL0CXp54I

  - http://infovis.cs.vt.edu/content/videos-0

    - (for more videos): https://www.youtube.com/watch?v=yrSyi1RWcUw

- For "real" (Facebook Oculus rift): https://www.youtube.com/watch?v=INDKNA7kXoo

  - Autodesk, Google (hiring), Facebook, … and many forward-looking institutions and research labs…

Never, ever underestimate the importance of having fun.
Randy Pausch

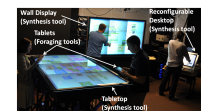# A lot of oohs, ahs, wows… but..

Applications

Brick walls are there for a reason. The brick walls aren't there to keep us out. The brick walls are there to show us how badly we want things.
Randy Pausch

Application areas are limited (Brooks 1999)
Many interaction design challenges (Bowman 2009)

Interaction Techniques for 3D Modeling on Large Displays

Bumptop? (google bought it!, is it the design you want?)
https://www.youtube.com/watch?v=6jhoWsHwU7w

Is it easy to interact with the environment?

- System components

  - Output: tactile / haptic feedback ; sound; modeling physics;

  - Visual content: modeling, rendering (realism);

  - Interaction: navigation, selection, manipulation

  - System factors: the level of immersion.

Universal Tasks

- Navigation

  - Steering - the continuous control of movement

  - Wayfinding - the cognitive process of choosing a path of movement

  - Searching - moving to see or reach a known object or location

  - Exploration - moving to learn or inspect unknown objects or locations

- Manipulation - changing the position and/or orientation of an object

  - Selection - indicating an object to manipulate or modify

  - Maneuvering - moving with small and precise motions

- System control - the issuing of abstract commands to the system, and

- Symbolic input - the communication of symbolic information to the system.

Selection & Manipulation

- Selection: specifying one or more objects from a set

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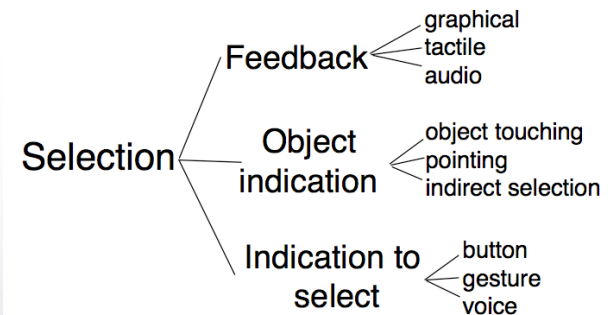
Goals of selection

- 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
  - Occluders

Selection classification

Selection
- Feedback
  - graphical
  - tactile
  - audio
- Object indication
  - object touching
  - pointing
  - indirect selection
- Indication to select
  - button
  - gesture
  - voice

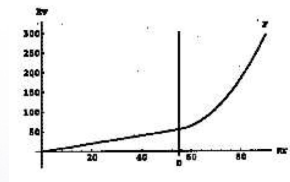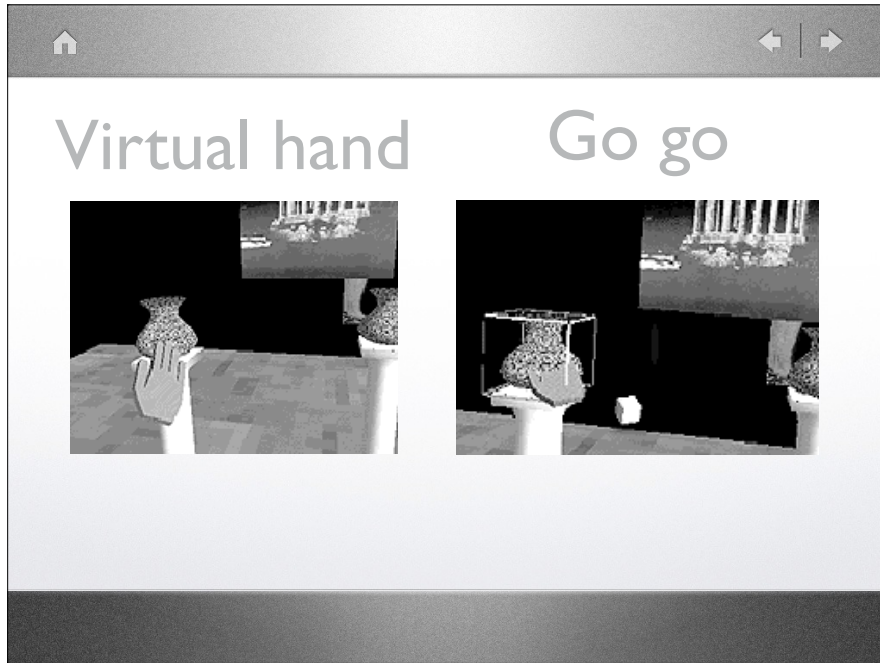## Common selection techniques

- Touching with virtual hand
- Ray/cone casting
- Occlusion / framing
  - are they the same?
- Naming
- Indirect selection
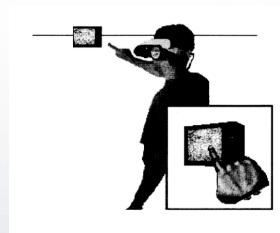
Enhancements to basic techniques

- Arm-extension
  - Mapping
  - "Reeling"
- 2D / 3D world in miniature
  - Select iconic objects

Virtual hand

Go go

Go-Go implementation

- Requires "torso position" t - tracked or inferred
- In each frame (implementation issue:
  - Get physical hand position h in world CS
  - Calculate physical distance from torso dp=dist(h,t)
  - Calculate virtual hand distance dv = gogo(dp)
  - Normalize torso-hand vector: th = (h-t)/|h-t|
  - V.hand position: v = t + dv * (h-t) (in world CS)

Interaction using customized input device (can we do better with sensors?)

Evaluation: selection task

- Which one is better?
  - Ray-casting, image-plane or Go-Go
  - Exception: selection of very small objects can be more difficult with pointing
- Ray-casting and image-plane techniques result in the same performance (2-DOF)
- Image-plane technique less comfortable

Improve Precision

- Arc-Pad (2F - 2 fingers): Progressive refinement | integrate solution

  - Modes in interaction

High-Precision Pointing on Large Wall Displays using Small Handheld Devices
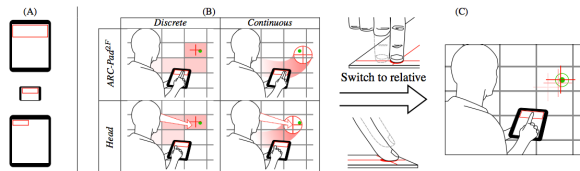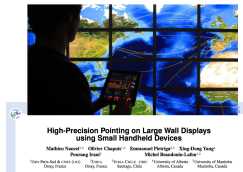
Figure 3. The four dual-precision techniques. (A) The three device / pointing zone pairs used in our experiments: tablet with large zone (Experiments 1 and 3), smartphone with small zone (Experiment 2) and tablet with small zone (Experiment 3). (B) The four coarse (absolute) modes, combinations of *Head* vs. *ARC-Pad²ᶠ* and *Discrete* vs. *Continuous*. (C) In all cases, using a single finger in the pointing area switches to precise (relative) mode.

Implementation issues for selection techniques

- How to indication selection event

- Object intersections

- Feedback

  - Graphical

  - Aural

  - Tactile

- Virtual hand avatar

- List of selectable objects

Goal of manipulation

- Object placement

  - Design

  - Layout

  - Grouping

- Tool usage

- Travel

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Manipulation metaphors

- Simple virtual hand

  - Natural but limited

- Ray casting

  - limited effort required

  - Exact positioning and orienting very difficult (level arm effect)

Manipulation metaphor

- Hand position mapping
  - Nature, easy placement
  - Limited reach, fatiguing, overshoot
- Indirect depth mapping
  - Infinite reach, not tiring
  - Not natural, separate DOFs

HOMER technique

- Hand-centered Object Manipulation Extended Ray-casting
- Select: ray-casting
- Manipulation: hand

Time
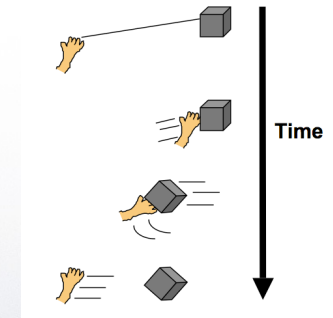
Manipulation metaphor

- HOMER (ray casting + arm-extension)
  - Easy selection & manipulation
  - Expressive over range of distances
  - Hard to move objects away from you

HOMER implementation

- Requires torso position t
- Upon selection, detach virtual hand from tracker, move v, hand to object position in world CS, and attach object to v, hand (w/out moving object)
- Get physical hand position h and distance dh = dist(h, t)
- Get object position o and distance do = dist (o, t)

World in miniature

http://vimeo.com/2208493

Manipulation metaphor

- Select world grab
  - +
  - -
- World in miniature
  - +
  - -

Summary

VE manipulation techniques
- Exocentric metaphor
  - World-In-Miniature
  - Scaled-world grab
- Egocentric metaphor
  - Virtual Hand metaphor
    - "Classical" virtual hand
    - Go-Go
    - Indirect, stretch Go-Go
  - Virtual Pointer metaphor
    - Ray-casting
    - Aperture
    - Flashlight
    - Image plane

Manipulation
- Object Attachment
  - attach to hand
  - attach to gaze
  - hand moves to object
  - object moves to hand
  - user/object scaling
- Object Position
  - no control
  - 1-to-N hand to object motion
  - maintain body-hand relation
  - other hand mappings
  - indirect control
- Object Orientation
  - no control
  - 1-to-N hand to object rotation
  - other hand mappings
  - indirect control
- Feedback
  - graphical
  - force/tactile
  - audio

Evaluation: positioning task

- Ray casting effective if the object is repositioned at constant distance

- Scaling techniques (HOMER, scaled world grab) difficult in outward positioning of objects: e.g., pick an object located within reach and move it far away

- If outward positioning is not needed then scaling techniques might be effective

Evaluation: orientation task

- Setting precise orientation can be very difficult

- Shape of objects is important

- Orientating at-a-distance harder than positioning at-a-distance

- Techniques should be hand-centered

Manipulation notes

- No universally best technique

- Constraints and reduced DOFs

- Naturalism not always desirable

- If VE is not based in the real, design it so manipulation is optimized

Manipulation enhancements

- Constraints

- 2-handed manipulation

- Haptic feedback
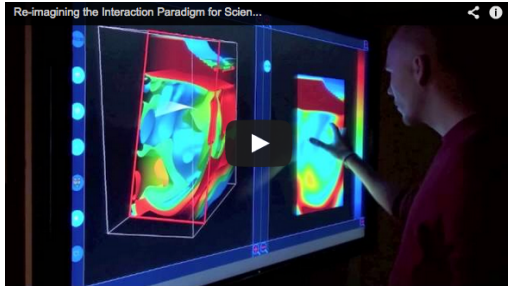
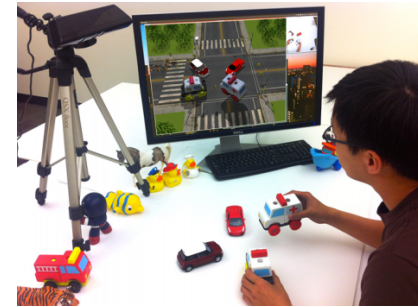- Multi-modal manipulation

Combined techniques?

- Finger glass

Interactive Visualization

- Touch, sketching, exploring:

  - http://tobias.isenberg.cc/VideosAndDemos/Keefe2013NIS

Visual Content Creation

- 3D Pupertry

  http://vis.berkeley.edu/papers/3dpuppet/

3D Puppetry: A Kinect-based Interface for 3D Animation

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Want to be cool,cool, cool & contribute to sciences?

Announcements

- Projects out soon - keep an eye on the main page: http://www.csee.umbc.edu/courses/undergraduate/435/Spring15/