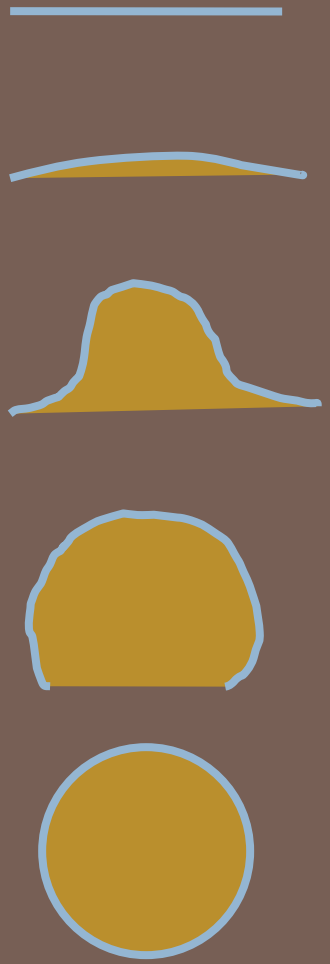


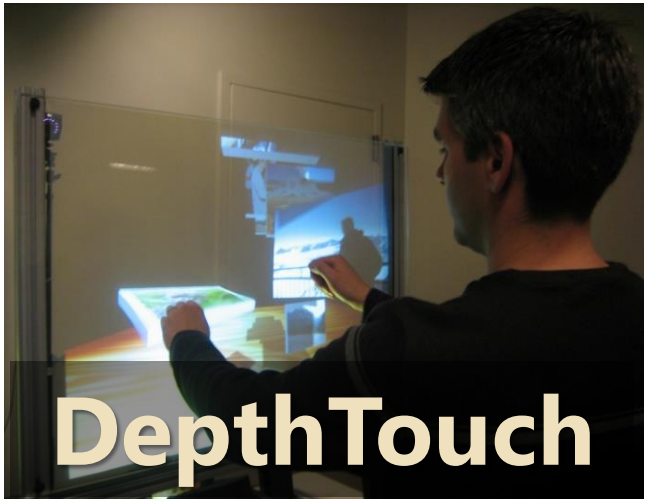
Non-Flat Surface Computing

Hrvoje Benko

Sept. 15th 2008 @ Microsoft Research Cambridge


Sphere

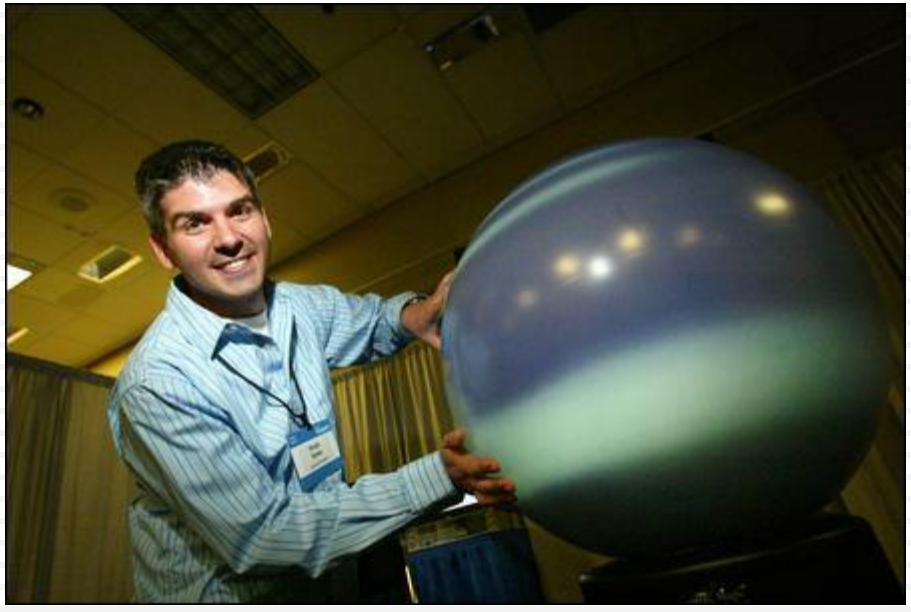

MiniSphere


DepthTouch

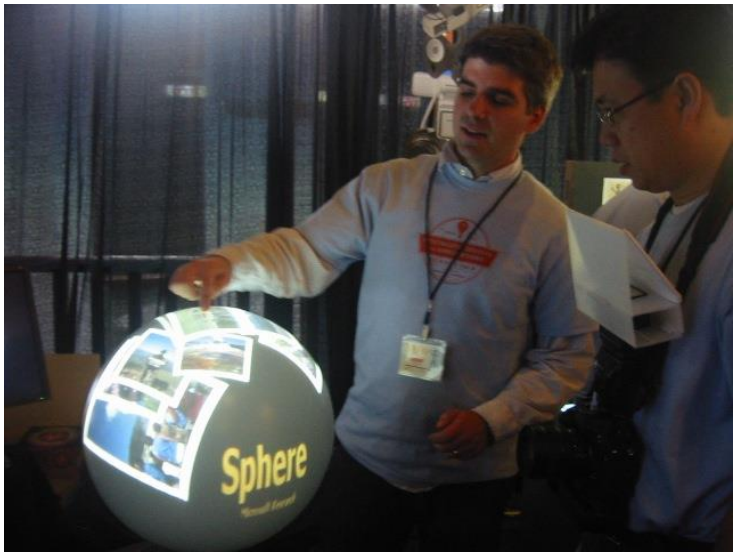

4x6

Sphere

with Andy Wilson and Ravin Balakrishnan



Multi-Touch Spherical Display

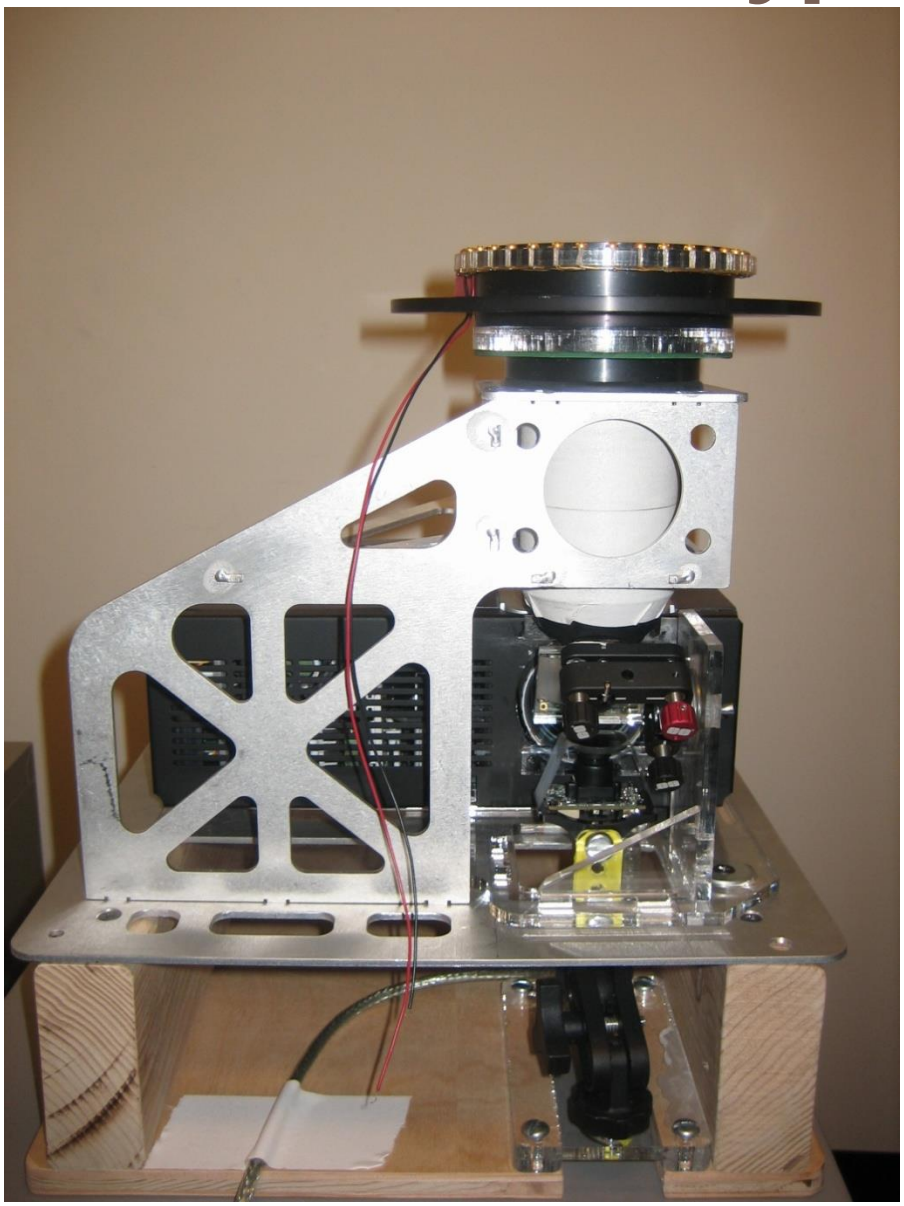


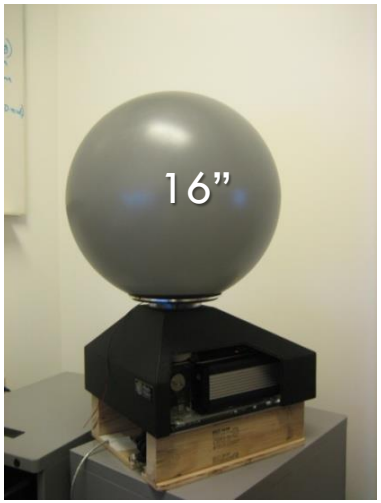
- 360° viewing
- Inviting to touch – Inherently shared
- Internal projection + sensing
- Built on Global Imagination's *MagicPlanet* display

Unique Properties

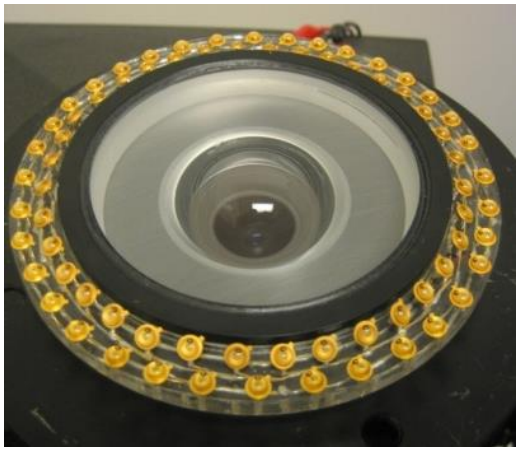
- Non-visible hemisphere
- No master user position / orientation
- Visibility changes with position
  - "Presudo-private" and "public" areas
- Smooth transitions in depth and orientations
- Borderless, but finite display
- Natural orientation landmarks
- Omni-directional room projection possibility
  - Instant CAVE

Hardware Prototypes

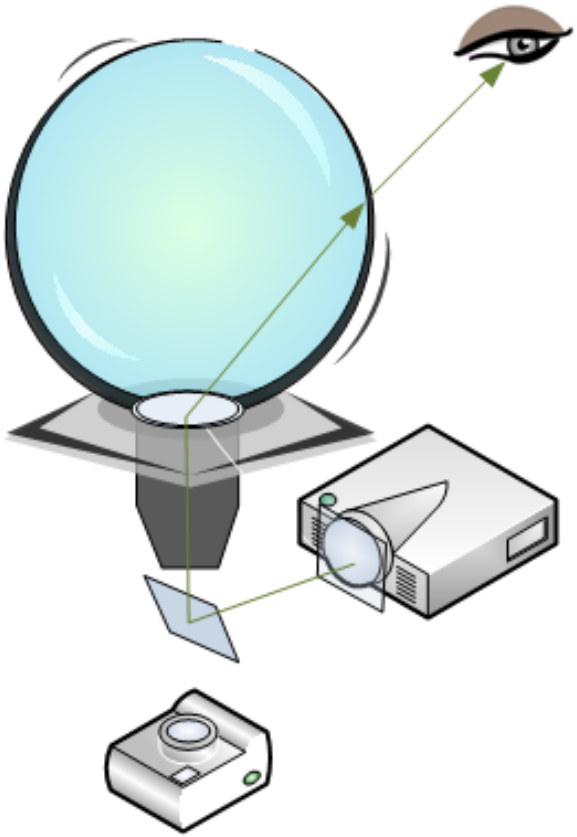




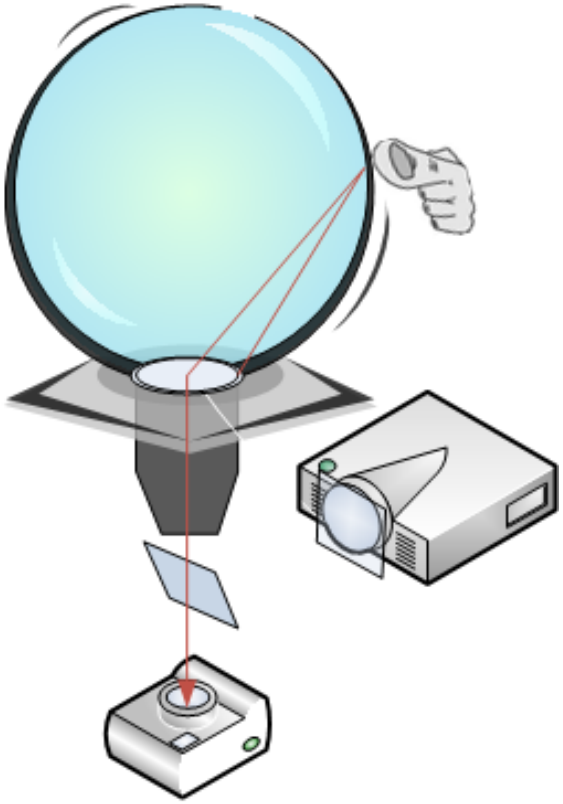
Hardware Setup



How does it work?

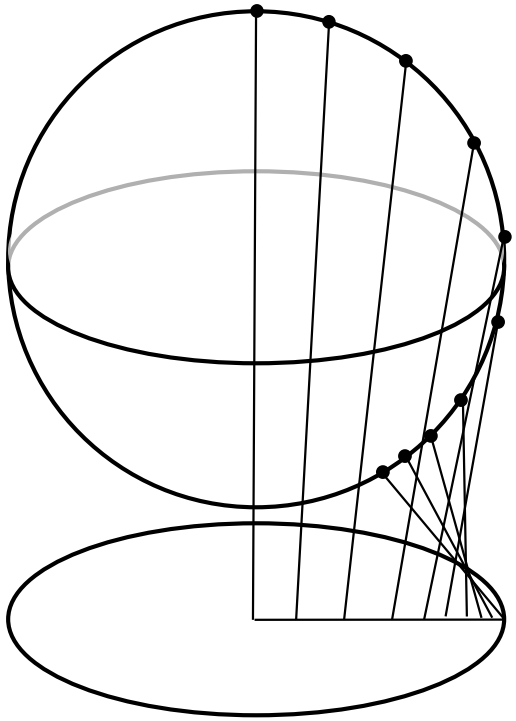


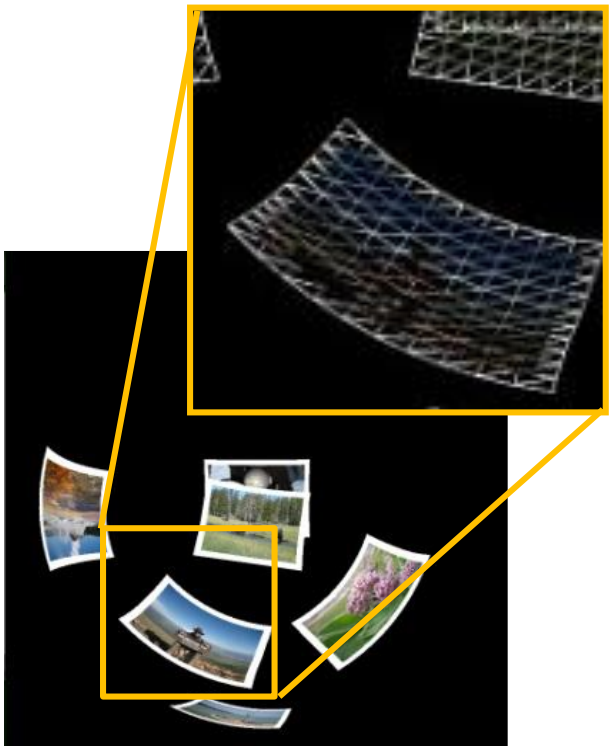
Projection path
(Visible)



Tracking path
(IR)

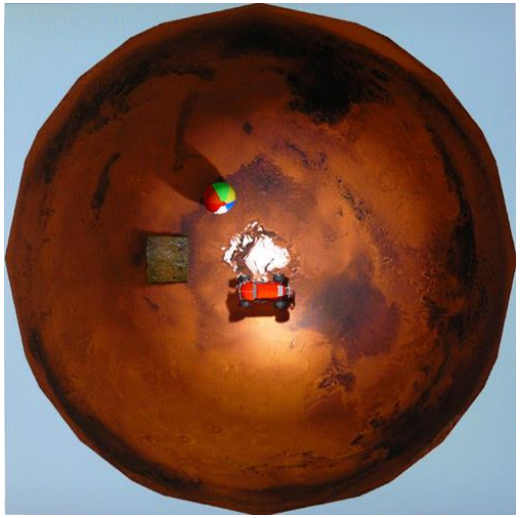
Sensing and Projection Distortions

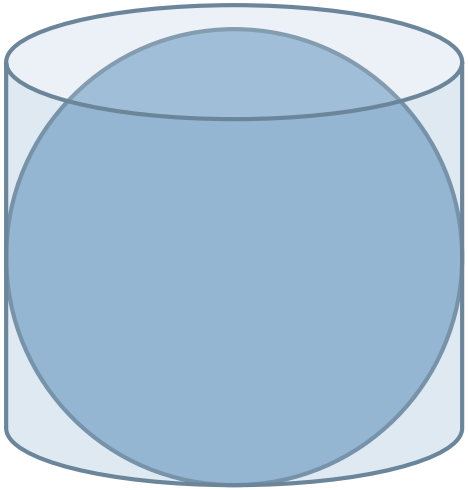




Authoring Dilemma: Choosing a Coordinate System

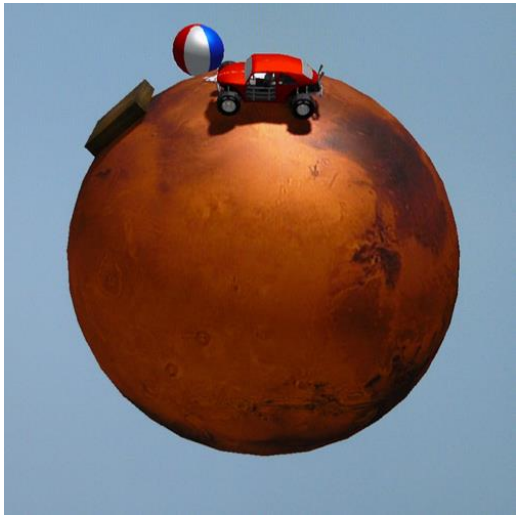
2D
(Disk)

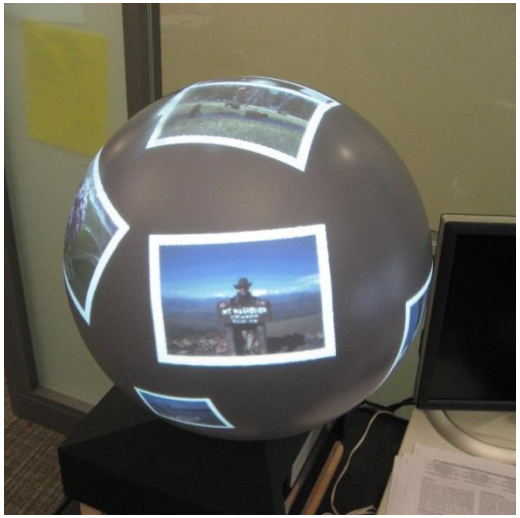




Flat
(Cylindrical)

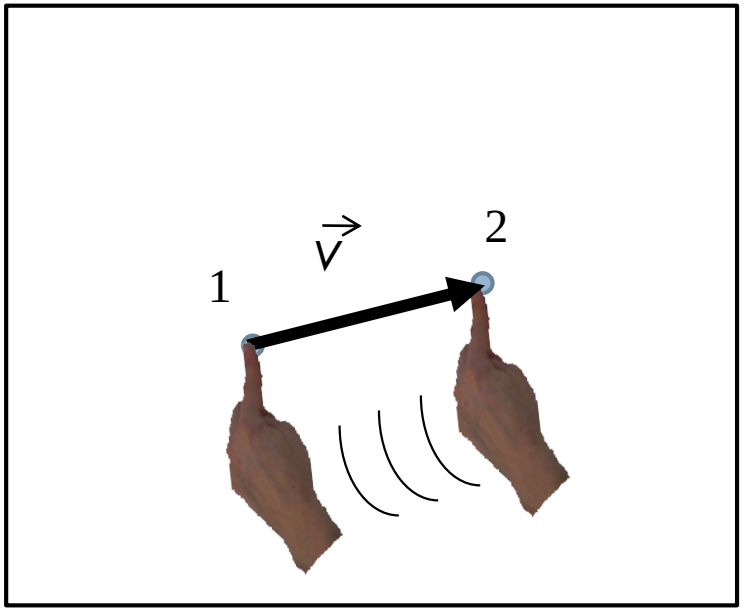
3D
(Spherical)



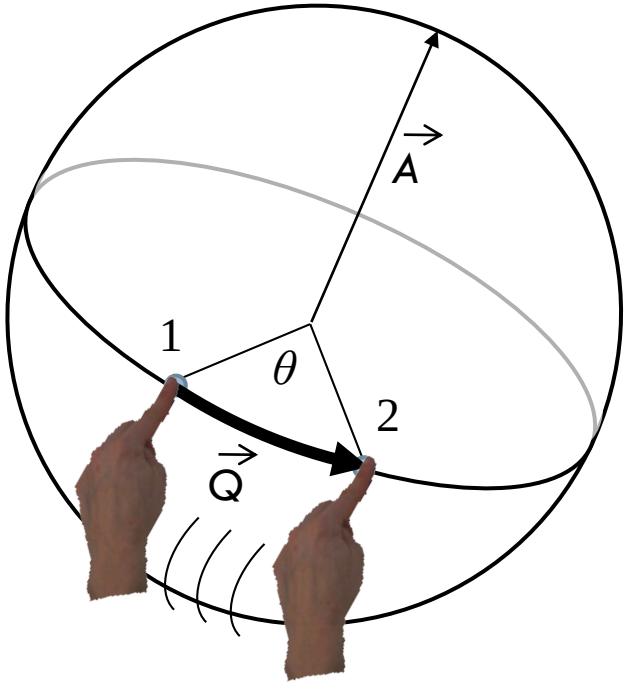


Hybrid
(Tangential
Plane)

Basic Interactions are Non-Trivial



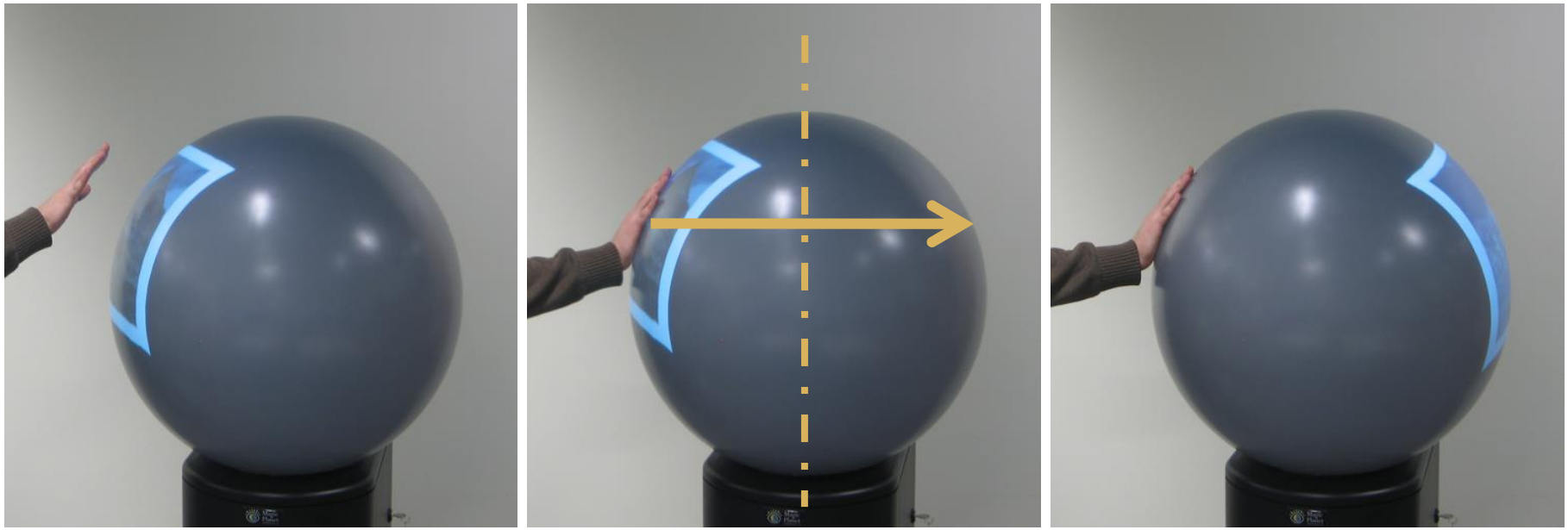
Flat Surface



Spherical Surface

Facilitating Sharing and Collaboration

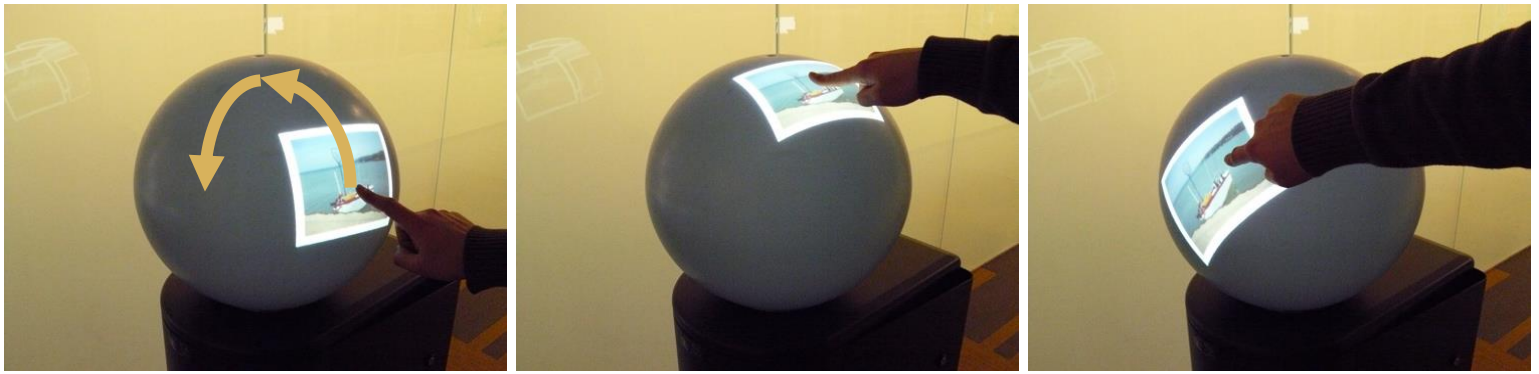
- Extend user's reach
  - *Flicking*
  - *Send-to-Dark-Side*



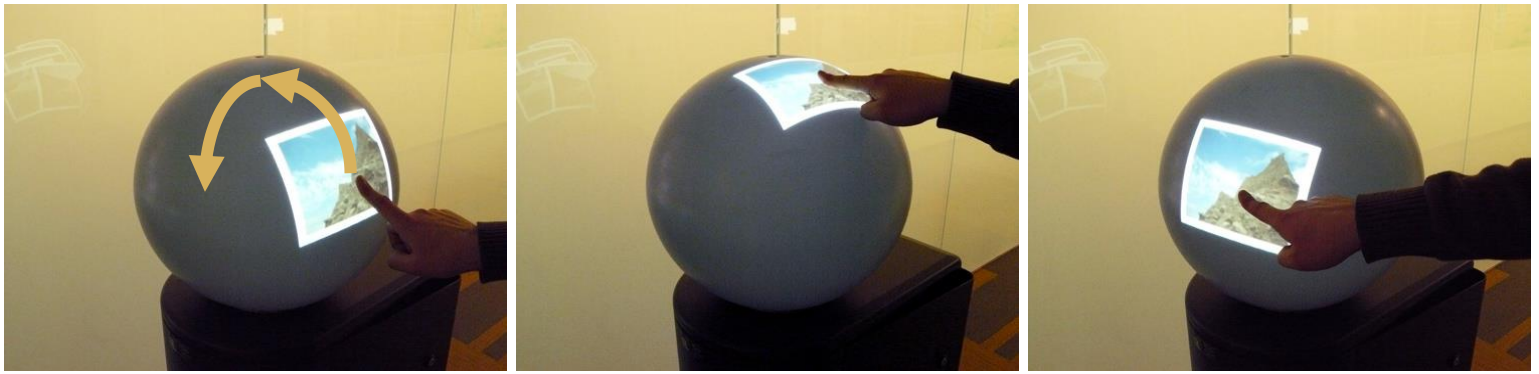
Facilitating Sharing and Collaboration

- Account for orientation difficulties
  - *Auto-rotation*

Default behavior

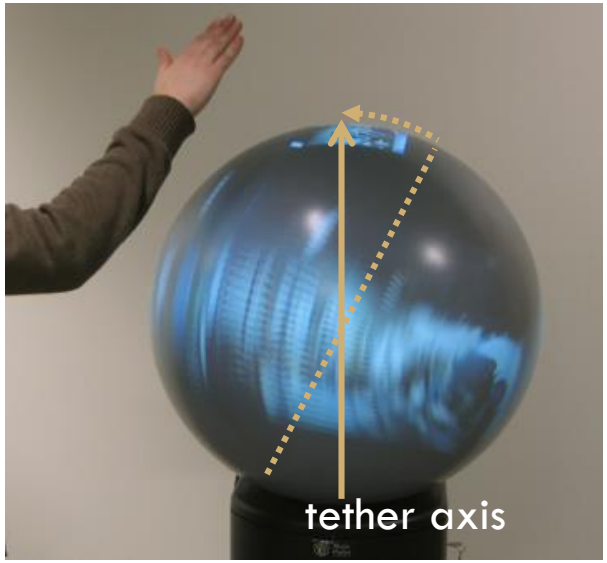


Auto-rotation



Facilitating Sharing and Collaboration

- Account for orientation difficulties
  - *Auto-rotation*
  - *Tether*



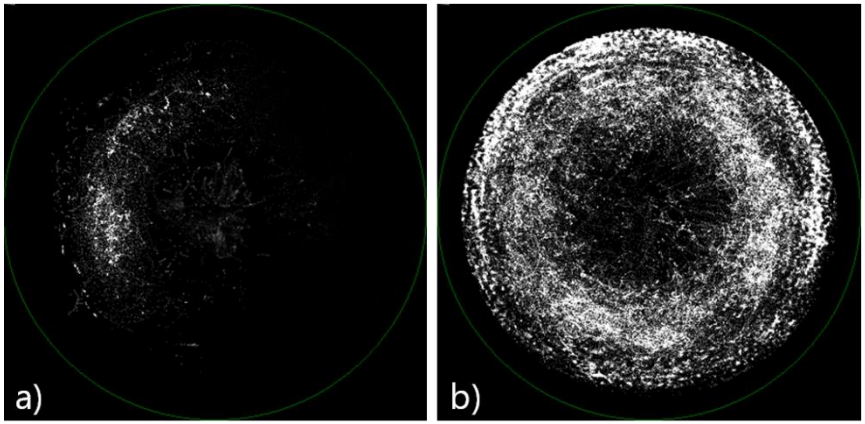
Facilitating Sharing and Collaboration

- Circular universally-visible menu
  - *Orb-like menu invocation*

Video: Sphere

Feedback

- Demos at
  - MS Hardware Science Fair ’07
  - MSR TechFest ’08
  - Faculty Summit ’08
- “Magical”, “Like a crystal ball”
- “What is it good for?”
- “I want one!”
- “Can I zoom?”



Sphere Zooming

With Bill Chen and Eyal Ofek from VE Research

MiniSphere

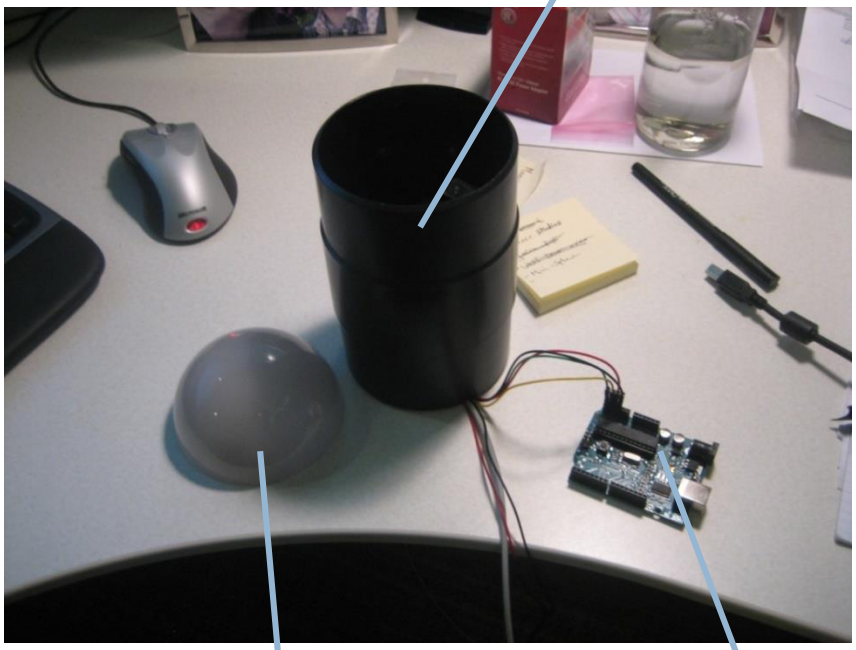
with Eyal Ofek, Bill Chen, and Andy Wilson

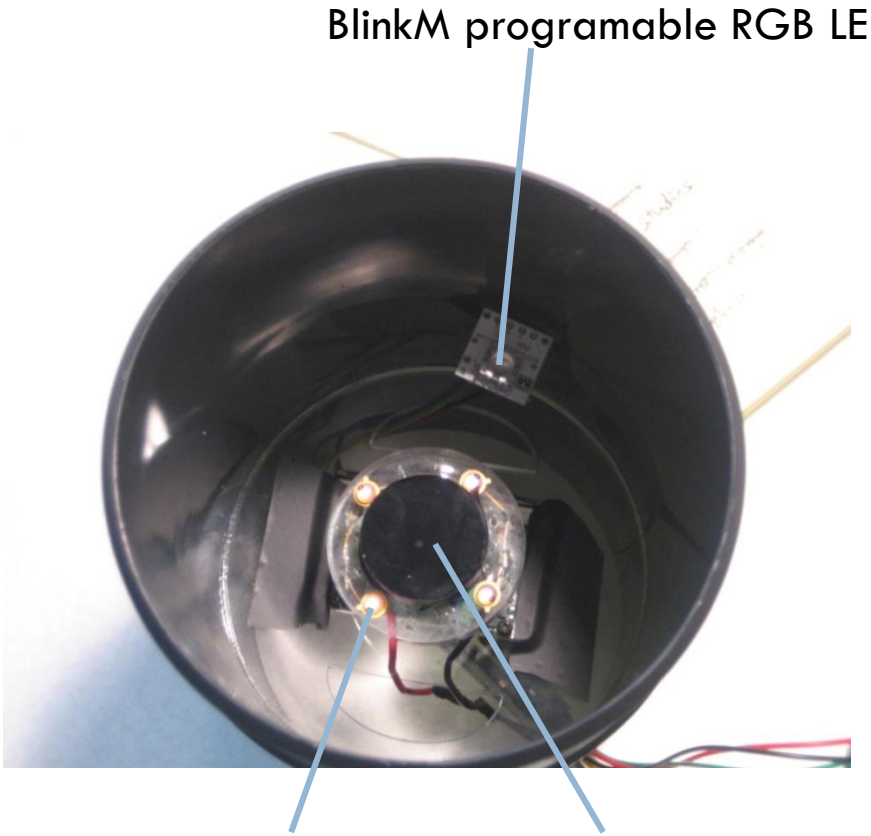
Two Spheres (of Interest)

MiniMe

MiniSphere

Hardware (DIY Version)





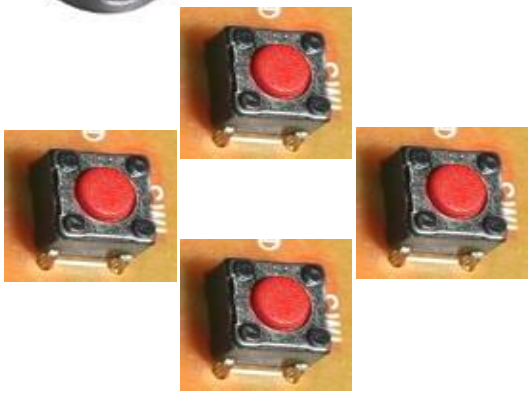
MiniSphere Characteristics

- Small (easily fits into your hand)
- Entire surface is reachable
- Higher curvature
- Higher sensing resolution
- Close to the hand at any point on the surface
- Hand occludes most of the surface

Possibilities

+

+

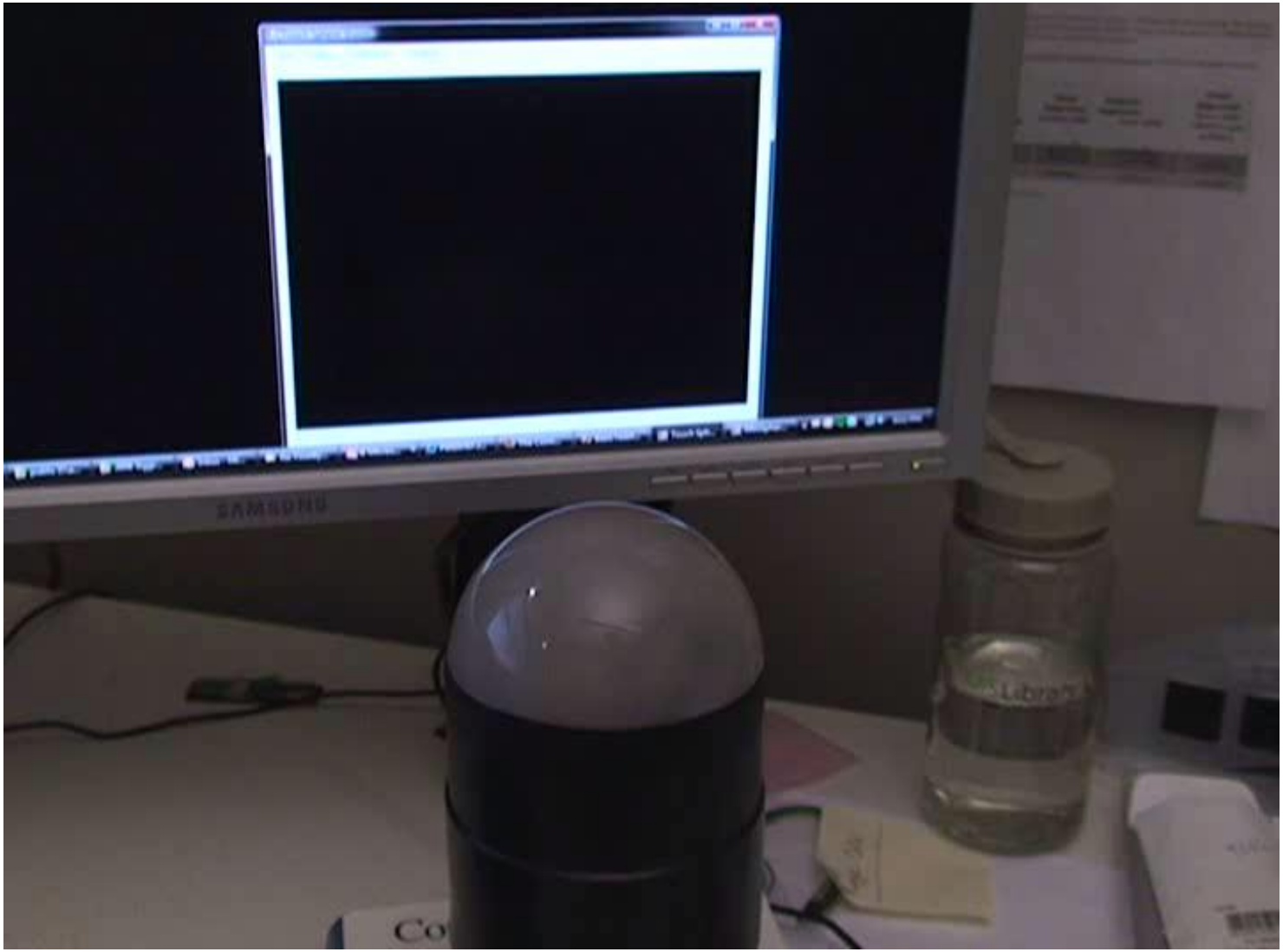


+

Video: Finger Detection

Video: Ball Playpen

Video: Binary vs. Edge Tracking



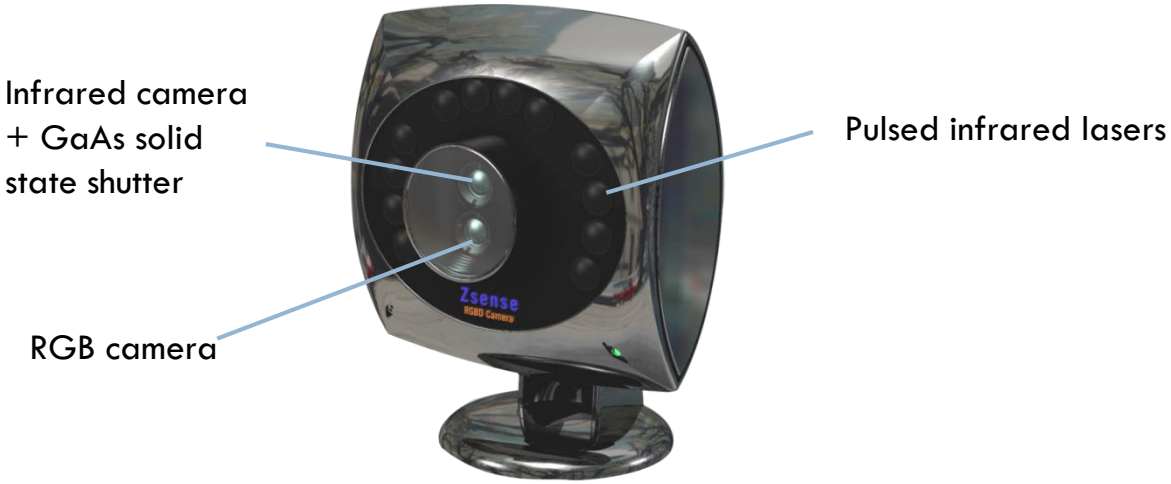
DepthTouch

with Andy Wilson

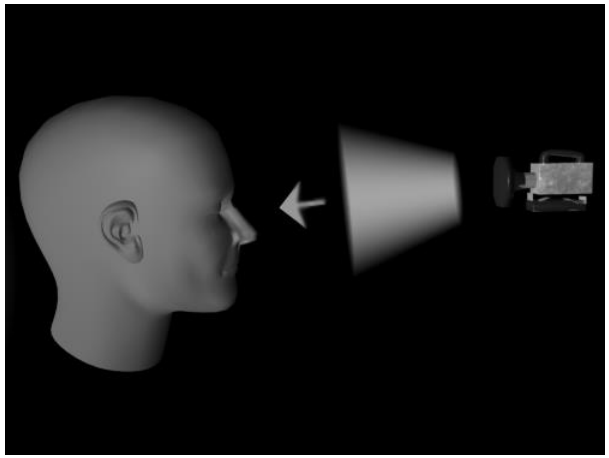
DepthTouch

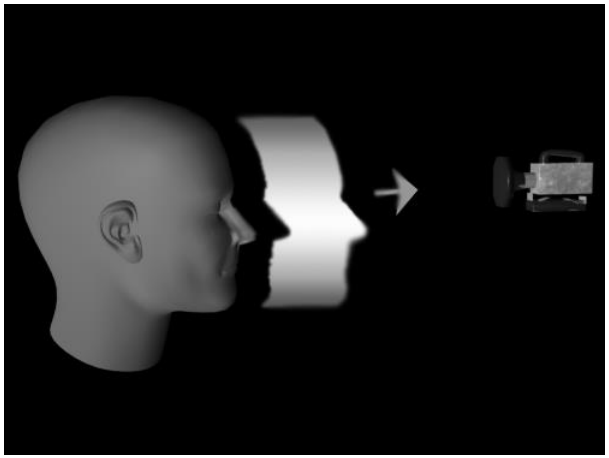
Above-the-Surface Interaction

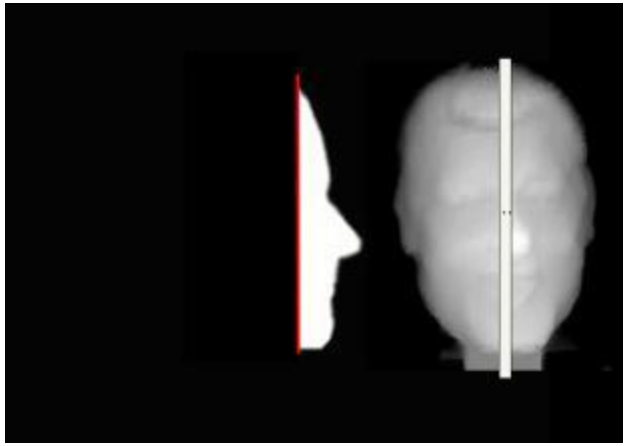
- New cameras give depth map + color: RGBZ
- Improves understanding of physical objects on surface
- Can compute ‘world coordinates’ directly

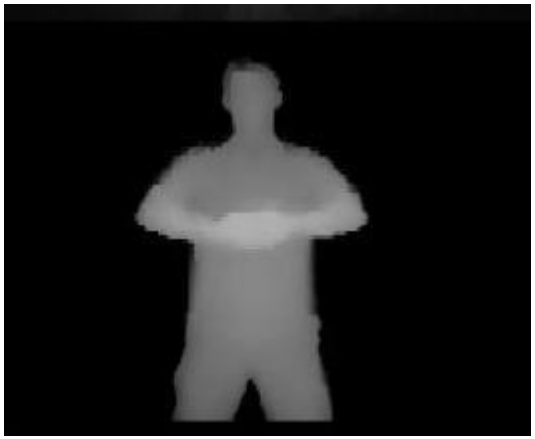


3DV ZSense Camera

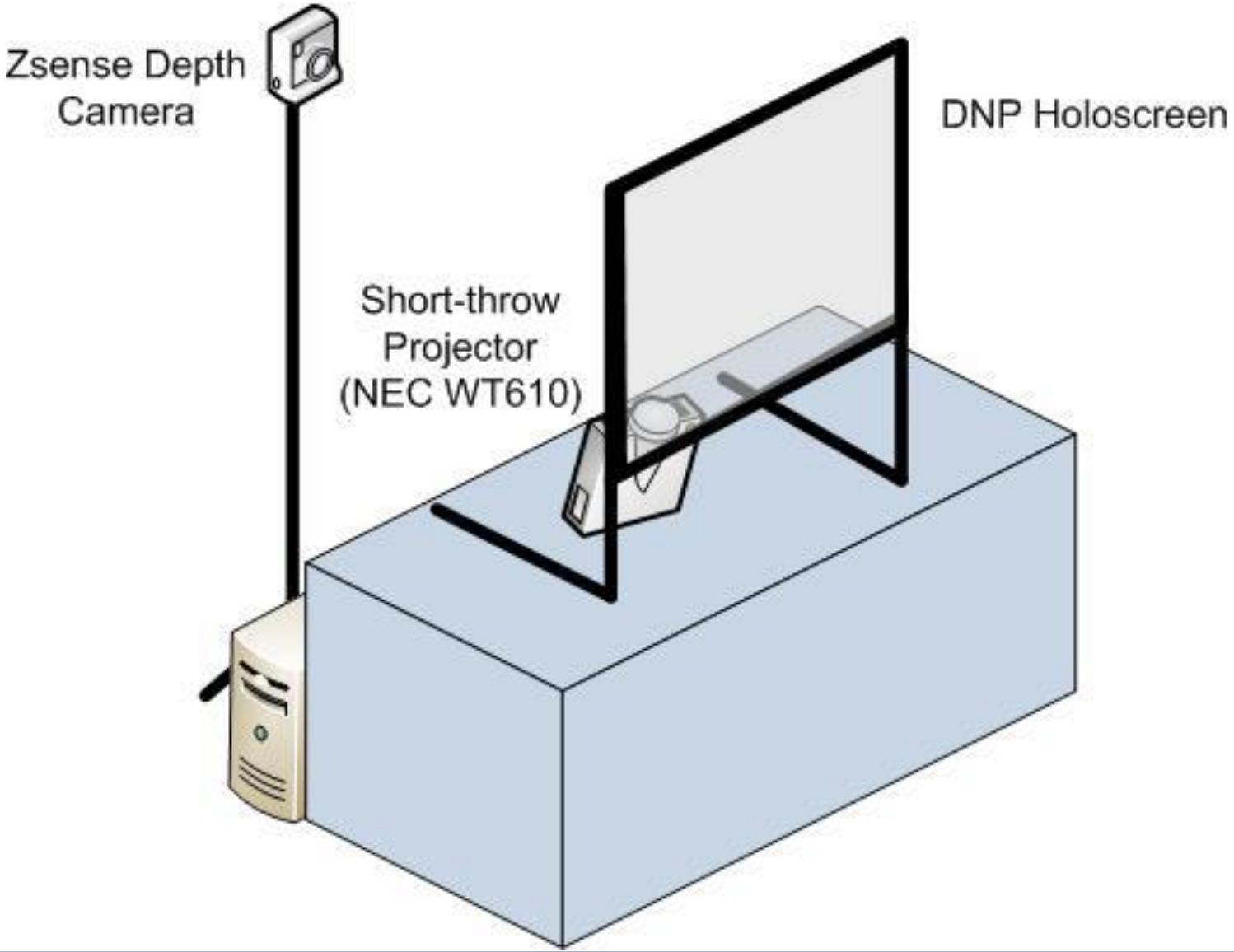








DepthTouch Hardware Setup



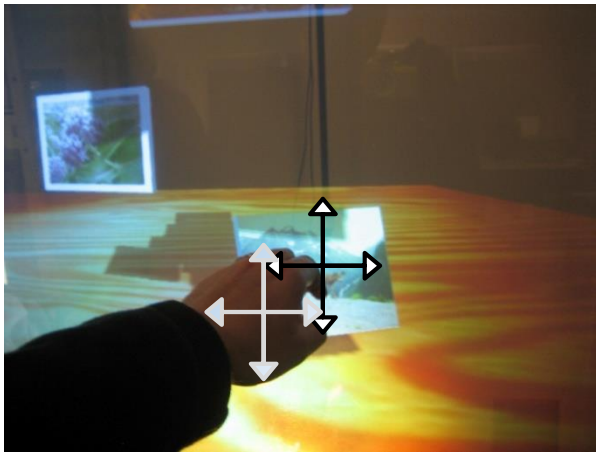
Tracking by Depth Segmentation

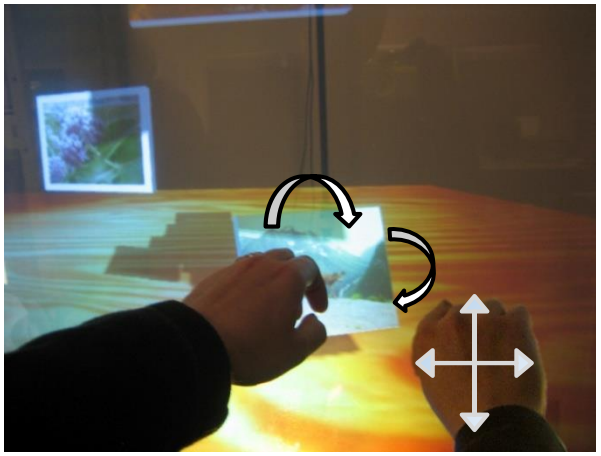
body

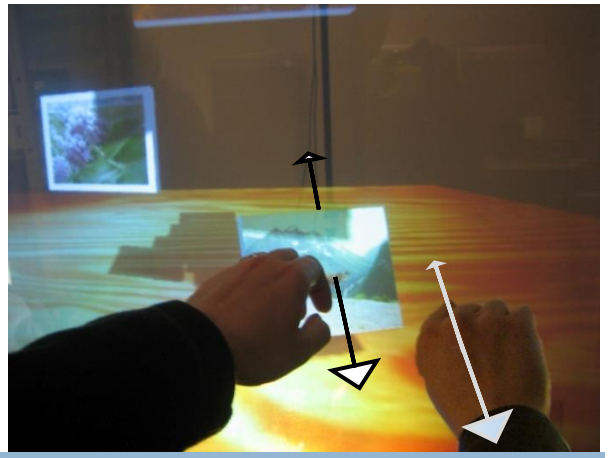
hands

Enabled Interactions

- Perspective view manipulations
  - Fishtank VR
- Touch-based manipulations
- Mid-air freehand interactions



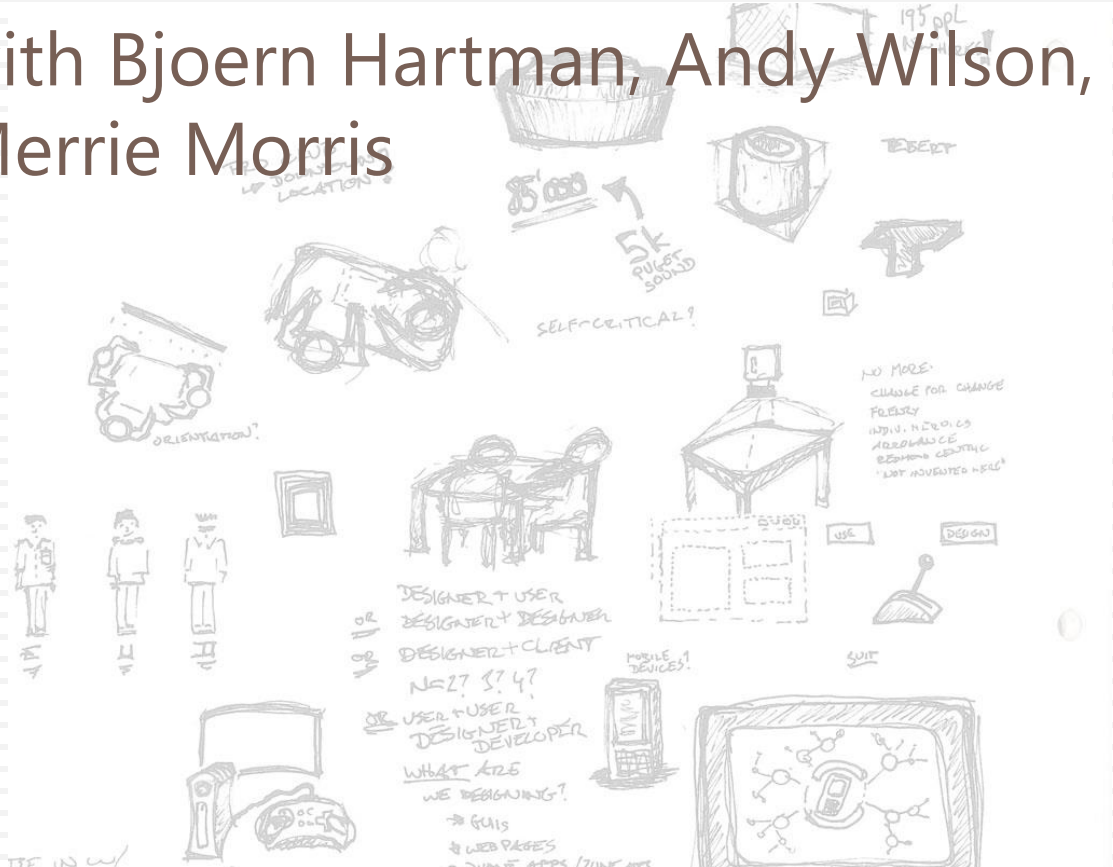




Video: DepthTouch

FourBySix

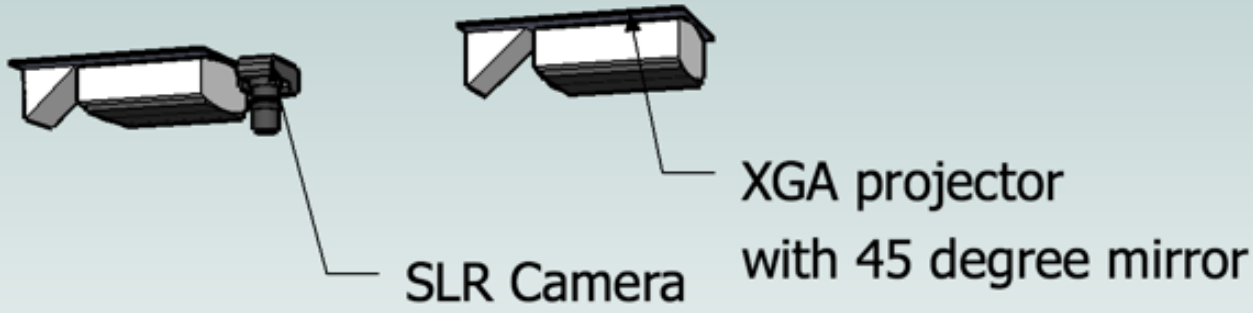
with Bjoern Hartman, Andy Wilson, and Merrie Morris



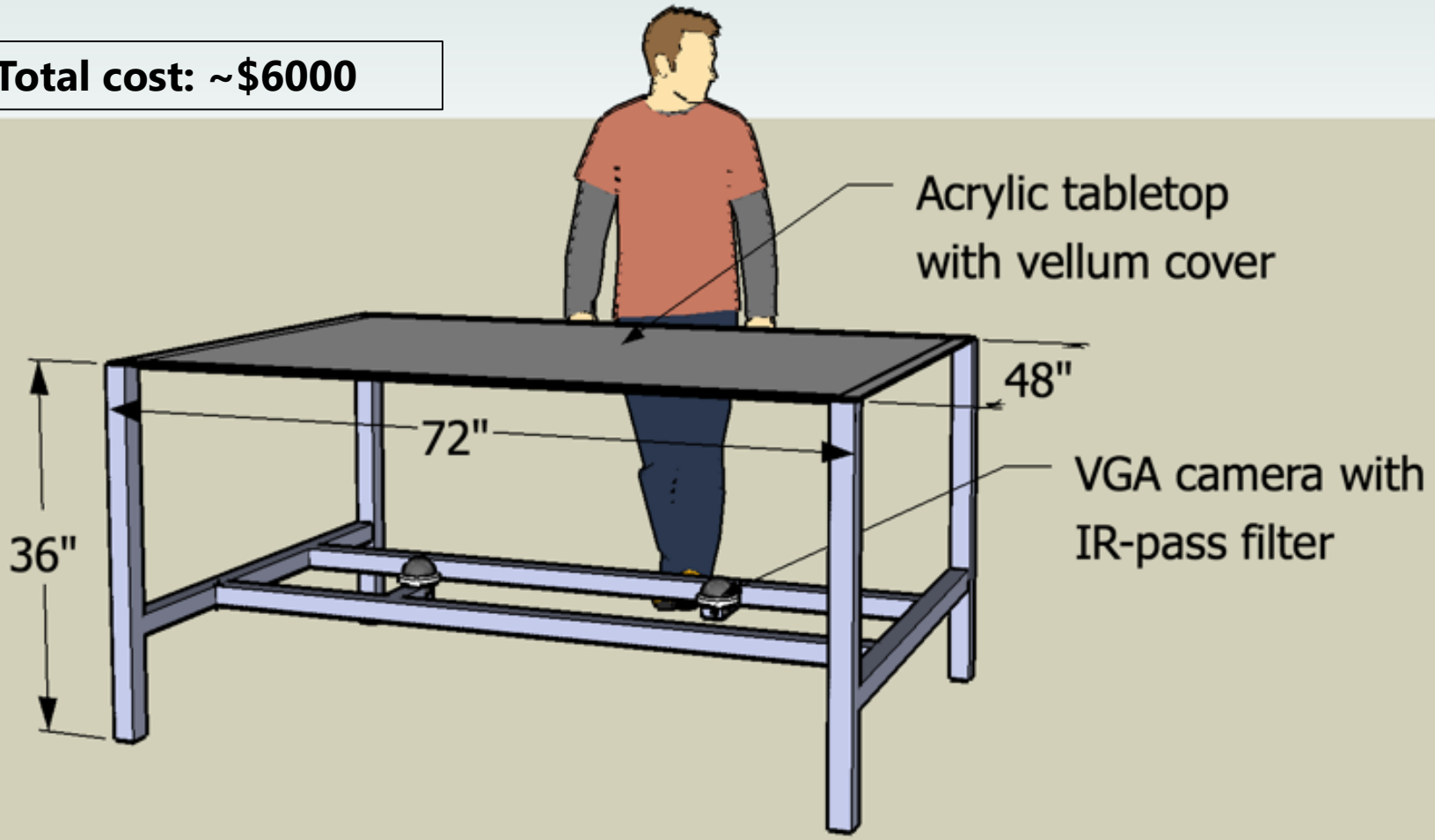
Goal: Facilitate Design Brainstorming

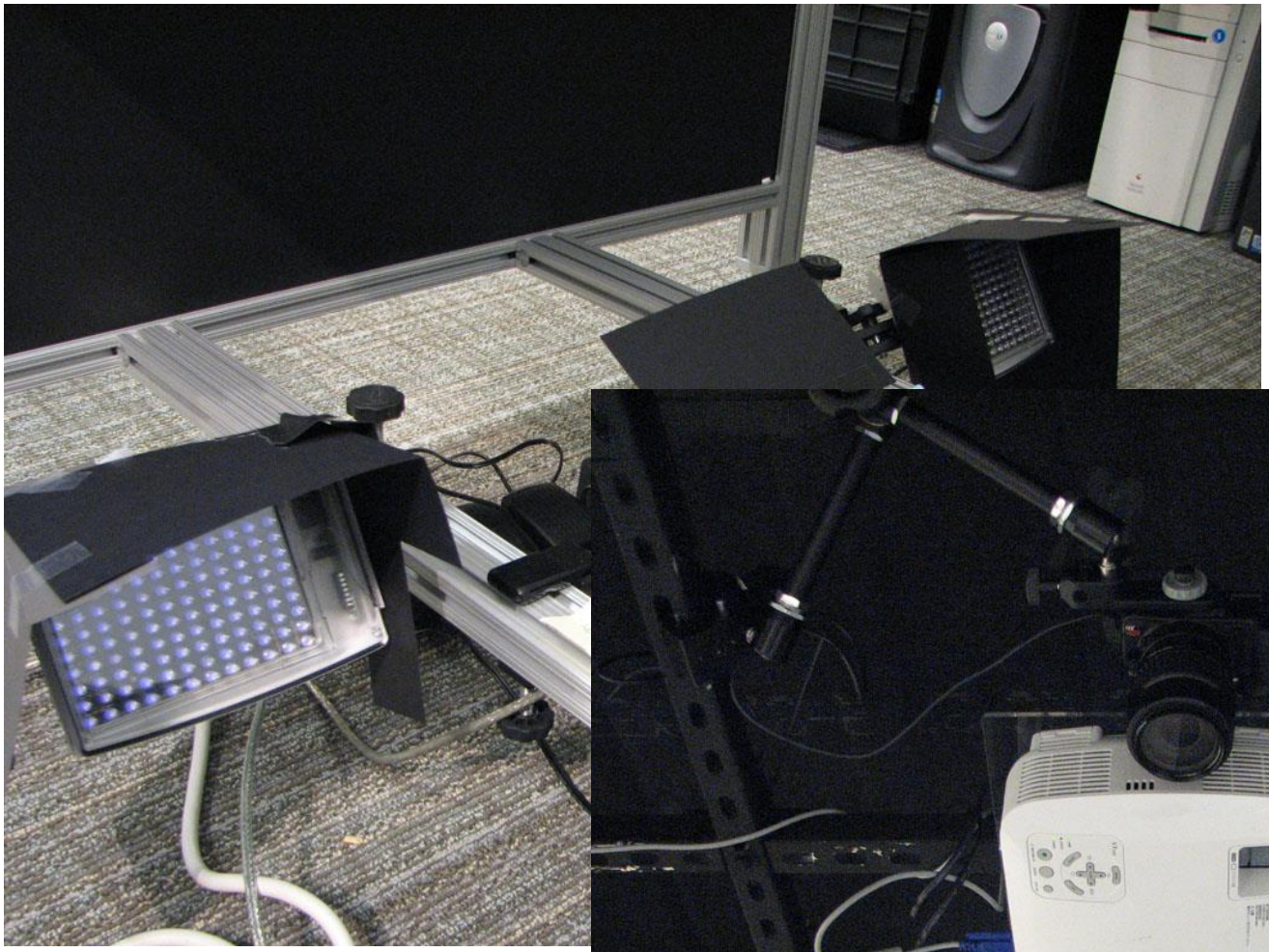
- Support multiple designers (no master user)
- Enable *rapid* capture, retrieval, annotation, and collection of visual material
- Fluidly move between physical and digital mediums
- Work with found, drawn, and captured imagery
- Organize images into functional collections
- Record meeting histories

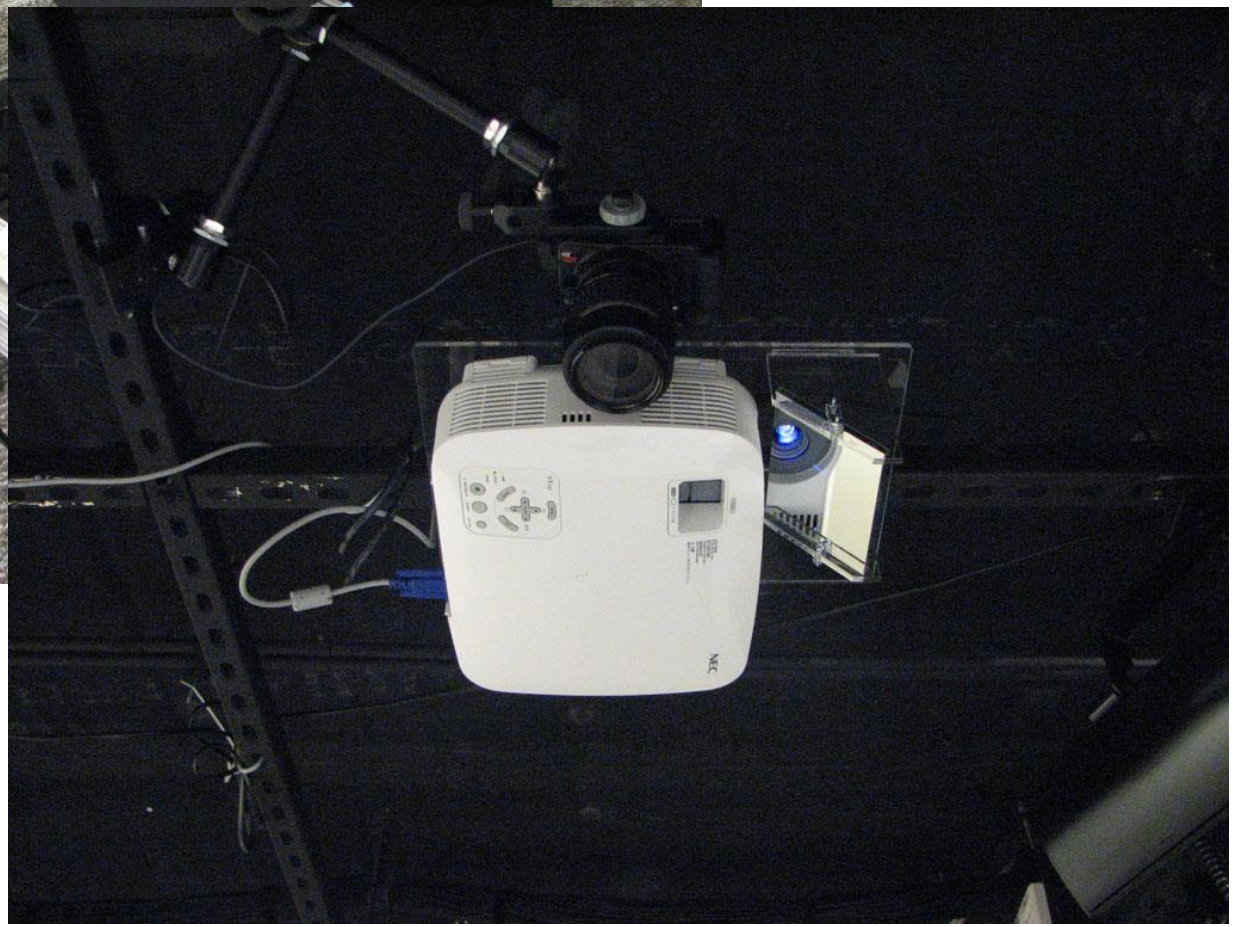
Hardware



Total cost: ~$6000







View From the Top (4272x2848 pixels, 60dpi)

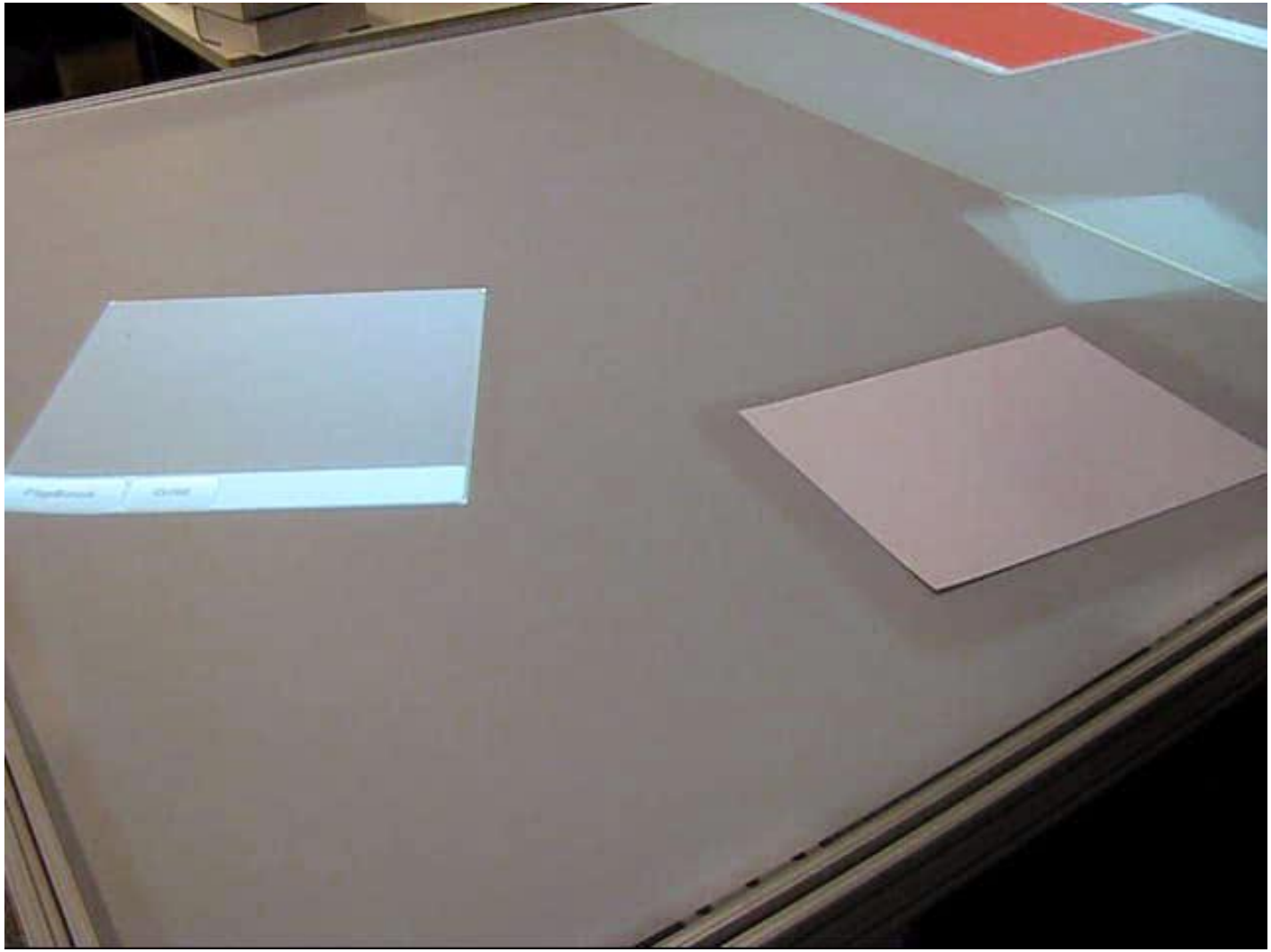
Software

- Surface SDK (*slightly* modified)
  - 1024x1536 pixels (21.3 dpi)
- Vision code (combines 2 cameras)
  - Fingers + Blobs @ 30Hz
  - 640x960 pixels (13.3 dpi)
  - Location, Orientation, Major/minor axes
- Canon EDSDK for still image capture
- Runs any Surface application

Annotating physical objects

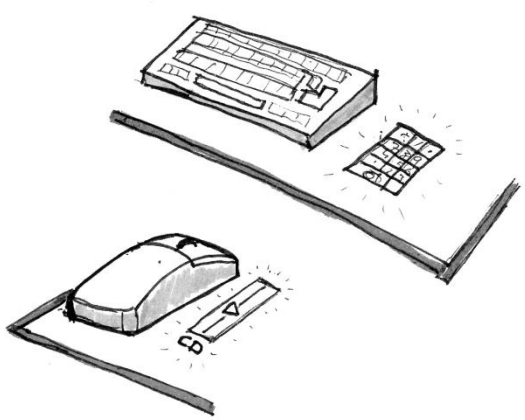
Video: Capture + Annotate

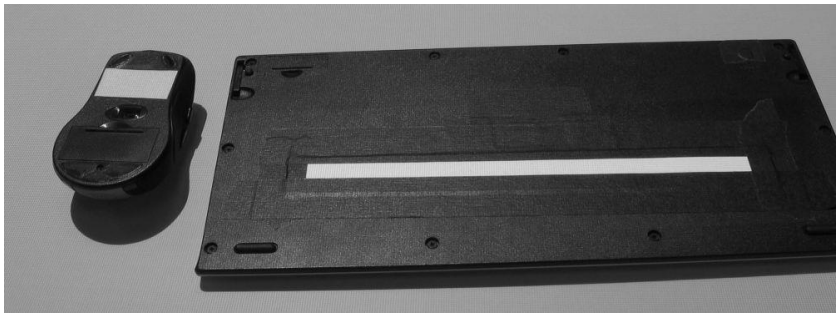
Video 4x6: Flipbook Collections

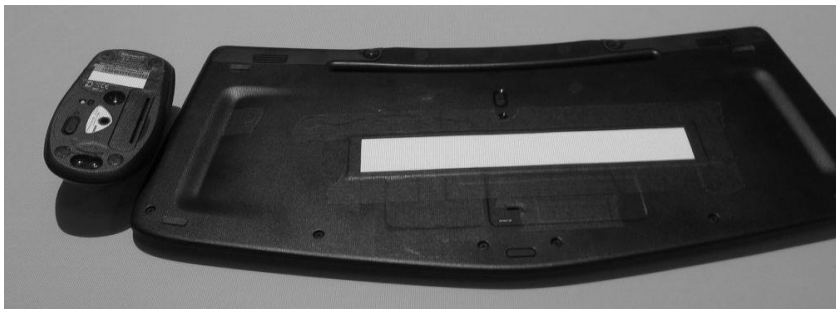


Supporting Multiple Input Devices

- Device-referenced display
- Context-sensitive device configuration

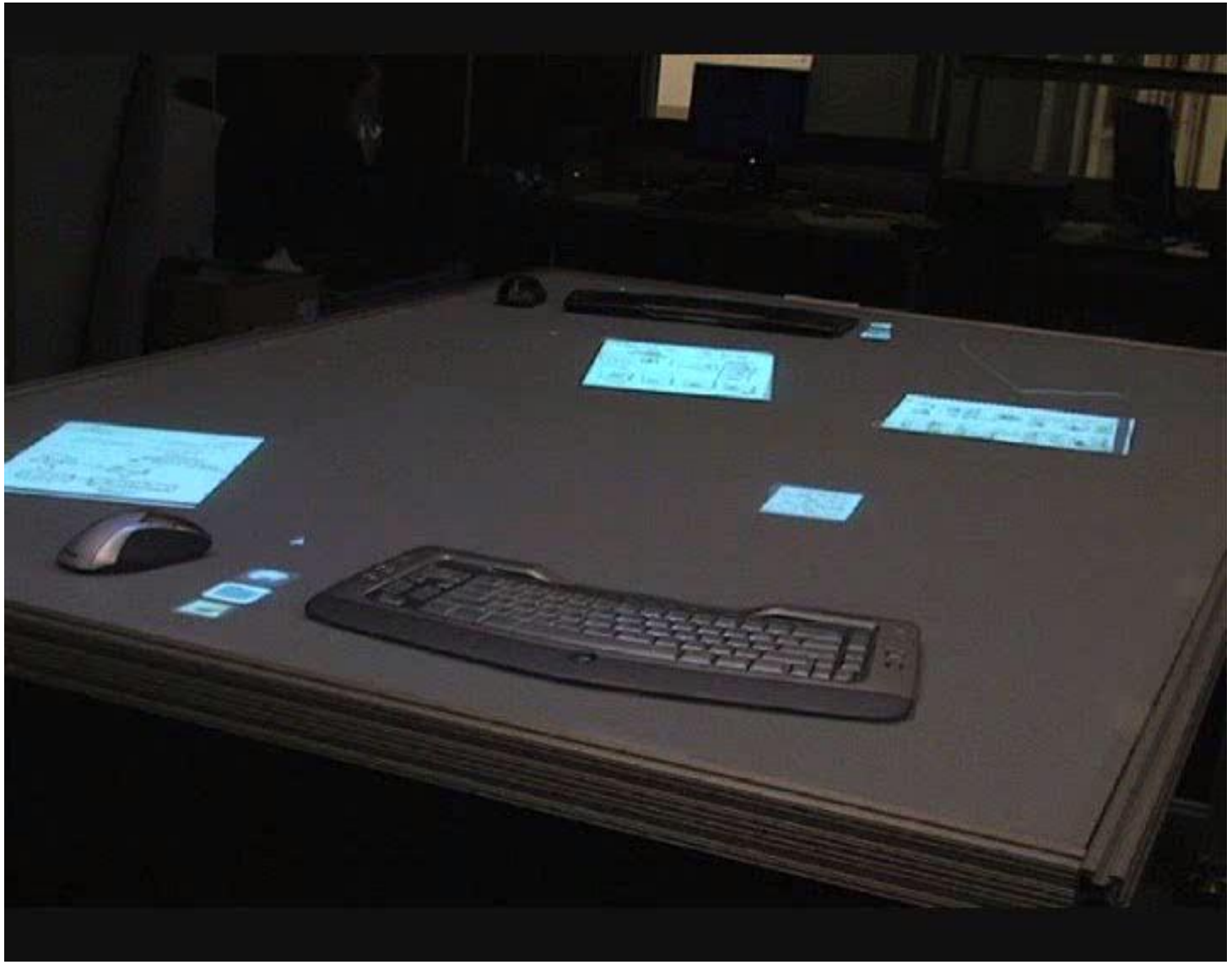




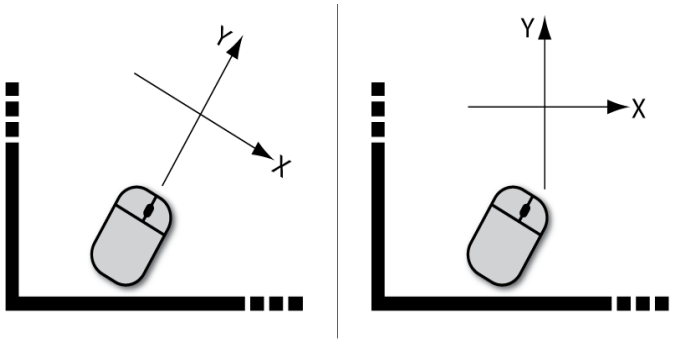


Video: Keyboard + Search

Video: Mice

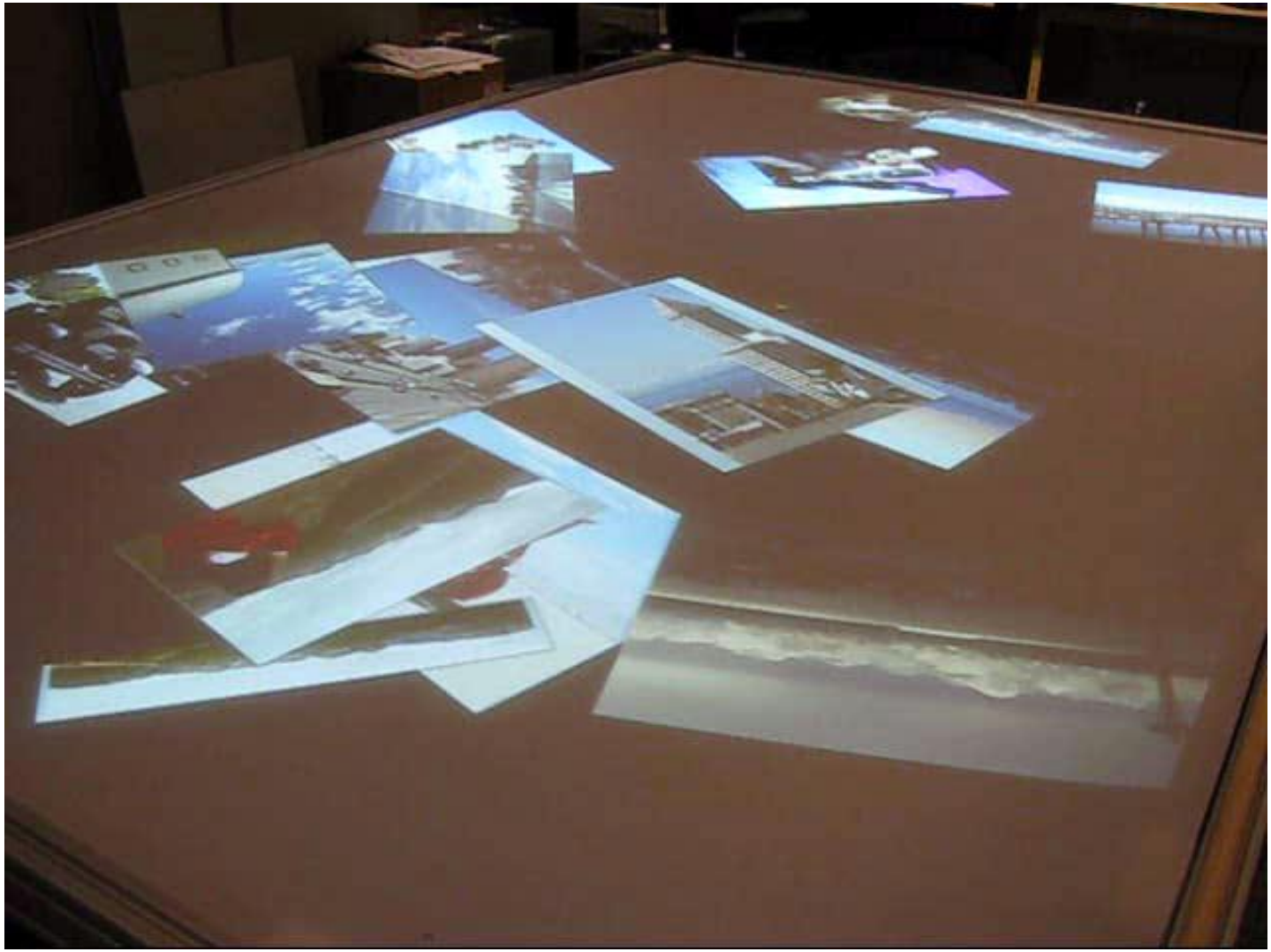


Dual Resolution Input: Combined Accuracy



	Microsoft Surface	4x6 Table	Standard mouse	Gaming mouse
Position sensing	Absolute; Coarse (~30dpi)	Absolute; Coarse (15dpi)	Relative; Fine (~600dpi)	Relative; Fine (~1200dpi)
Orientation sensing	Coarse (~1 degree resolution?)	Coarse (~1 degree resolution)	None	None
Sensing rate	60Hz	30Hz	125 Hz	1000Hz

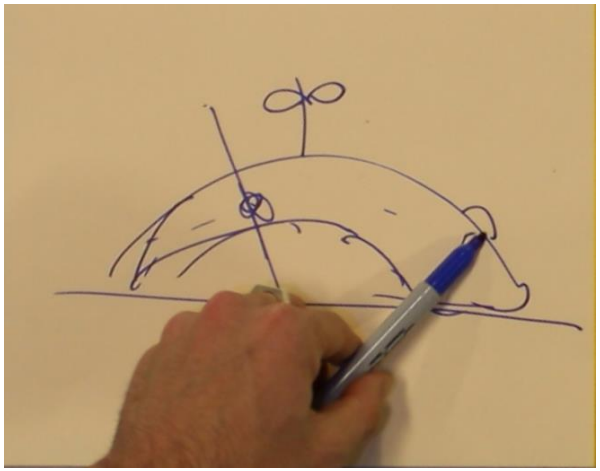
Video: *Croupier*-Style Interactions



Video: Rapid Prototyping Scenario

Preliminary Observations

- 16 designers
  - Groups of 1-5
  - No set task
- 8 students
  - Groups of 2
  - Set design task
- Many impromptu behaviors
  - Hands, laptops, objects
- For brainstorming: interaction speed is preferable to accuracy



Video: Session Record from the Top

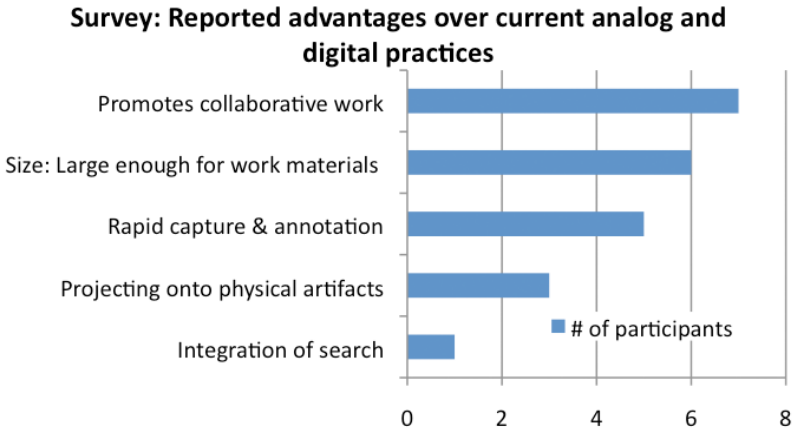
Summary

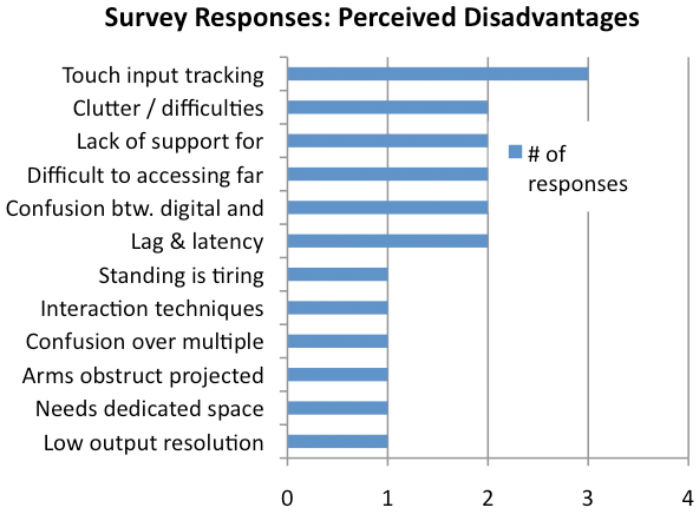
My projects explore the space where the flat digital world of surface computing meets the curved, physical, 3D space we live in.

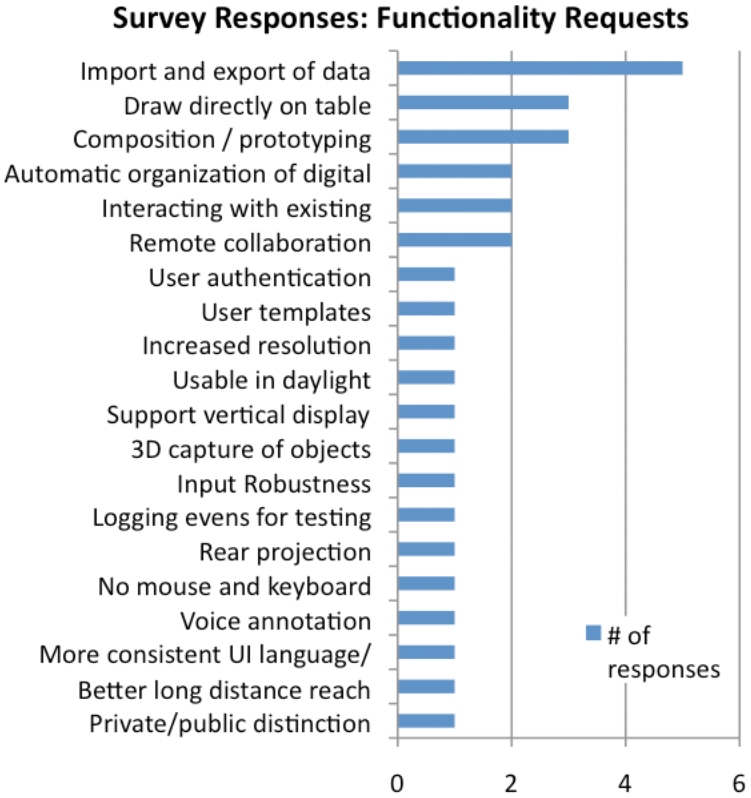

benko@microsoft.com
http://research.microsoft.com/~benko
Microsoft Research

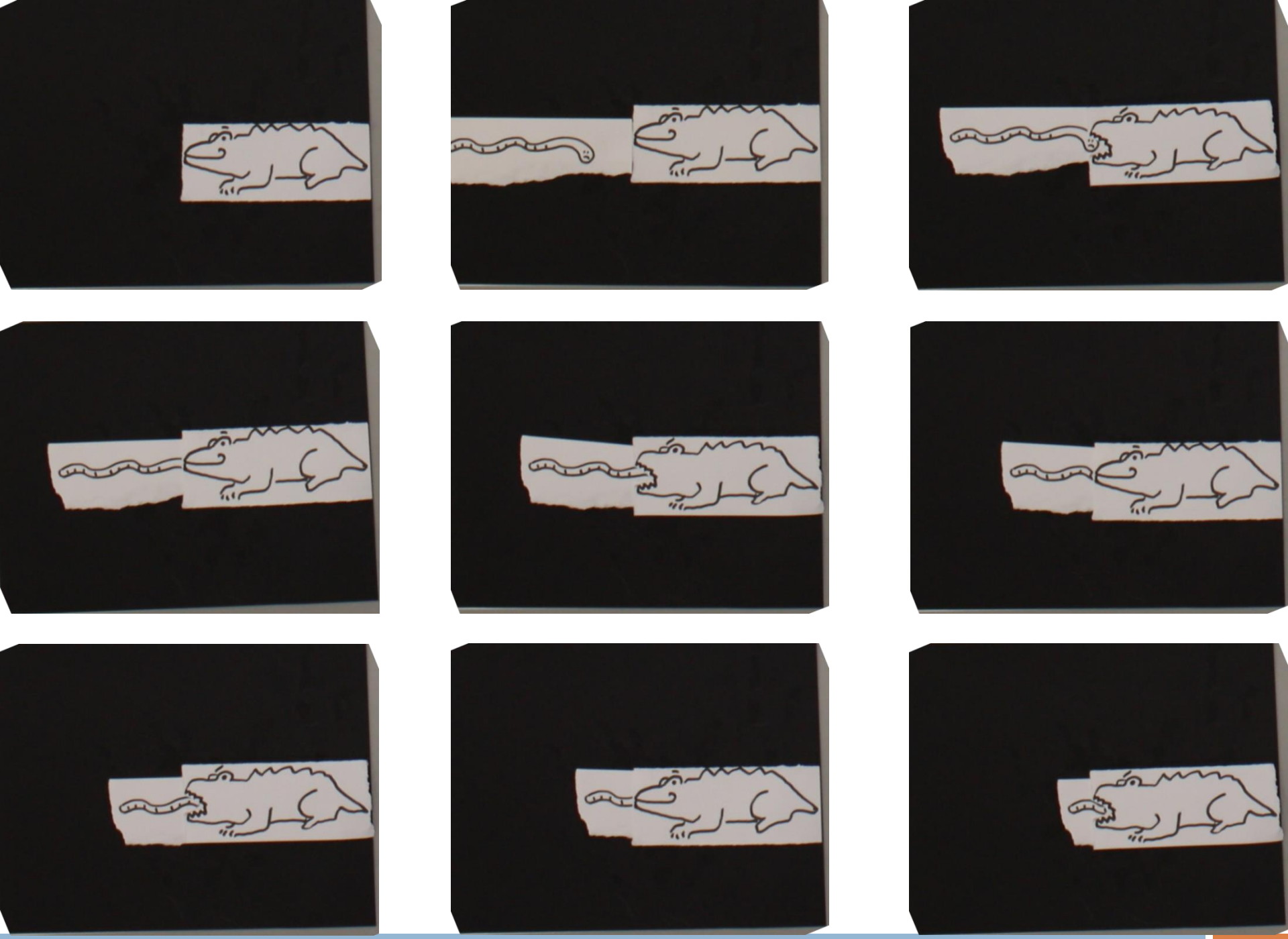
Extra Slides

Survey Results









Applications

- Visualizing spherical data
  - Planets, stars
- Public information booths
- Remote omni-directional visualization
  - Sphere + RoundTable
    - 360 deg. video-conferencing
  - Robot operation
- Ambient Displays
- Large displayable input device
  - Trackball
  - Space Mouse / joystick
- Games