Controlling Viewing Orientation

- Head tracking
  - Natural
  - Improves spatial understanding
- Orbital viewing (J. Chung, *I3D 92*)
  - Select position $p$ and distance $r$
  - Head rotations are mapped to move viewpoint about surface of sphere with center $p$ and radius $r$, looking at $p$
    - Look left, right, up, down to see object’s right, left, bottom, top, respectively
  - Good for inspection of one object at $p$, but…
  - Can be confusing with more objects in environment
    - Can cause cybersickness
Controlling Viewing Orientation

- Nonisomorphic rotation
  - Modify treatment of user orientation while walking
  - Redirected Walking (S. Razzaque)
    - Provide user with experience of walking in a much larger environment
    - $m^* \text{ real rotation } \rightarrow \sim \frac{1}{2} m^* \text{ virtual rotation}$
    - Inject most of distortion while changing physical orientation, add the rest while walking
  - Redirected Walking in Place (S. Razzaque)
    - Avoid having user look at missing CAVE rear wall to maintain presence
    - Gradually “adjust” world orientation while user walks in place

- Redirected walking with distractors
  - Distract user attention while distorting the mapping of real orientation to virtual orientation
  - E.g., virtual butterfly flutters in front of the user while walking in a virtual outdoor environment
Redirection for Hand-Helds
O. Oda & S. Feiner, ISMAR 2009

- Knock down other player’s dominos by shooting balls from screen

- AR Domino Knockdown
  - Two-player FPS

How to avoid unwanted physical collisions?

- Redirected Motion
  - Shifts virtual location of tracked device ahead of physical location as one player moves toward another player
  - Shifts back as first player retreats

Inspired by Redirected Walking [S. Razzaque et al. 2001]
Redirected Motion: Green Player’s POV

Ghost views of displays show virtually shifted locations

Redirected Motion: Green Player’s POV

Ghost views of displays show virtually shifted locations
Redirected Motion: Green Player’s POV

Ghost views of displays show virtually shifted locations

Redirected Motion: Third-Person POV
Redirection for Hand-Helds
O. Oda & S. Feiner, ISMAR 2009

- User study
  - Compared 9 pairs of participants playing with/without redirected motion, and other techniques
- Redirected motion
  - Kept users farther apart
  - Was undetectable when used with parameters set in pilot study

Redirection by change blindness
E. Suma et al., VR 2011

- Change Blindness
  - Failure to notice a large visual change when attention is distracted from the change
  - For general information/examples, see http://www2.psych.ubc.ca/~rensink/flicker/

- Change location of virtual door while user isn’t looking
- With right environment design, trick user into thinking they’re navigating a larger environment with a different layout
Redirection by change blindness
E. Suma et al., VR 2011

Questionnaire
- Mean outcome questions (blue) embedded in decoy questions
- Only one participant of 77 in two studies definitively noticed a scene change

Embedded Questions

Error Bars: 95% CI
Redirected touching
L. Kohli, M. Whitton, F. Brooks Jr., 3DUI 2013

- Apply redirection to selection and manipulation, rather than travel
- Warp user’s view of interaction to map real world to a different virtual world

- User sees virtual monitor at 18° rotation while performing selection task with real monitor at 0°
- After practice, no significant differences in throughput, error rate, path variability found compared to virtual and real monitor at 18°

Controlling Direction and Velocity Through Weight Shifting

- Virtual steering (direction and speed) based on weight shift as sensed by active “floor”
- Z-Tiles (Richardson et al., 2004)
  - Each tile has an array of 20 force-sensitive resistors to detect pressure
  - Tiles contain processors and connect to form a self-organized network
Controlling Direction and Velocity Through Weight Shifting

- Rotating/tilting chair instrumented with 6DOF tracker
  - S Beckhaus et al., 3DUI 2005
- Wii Balance Board
  - A Hilsendeger et al., GI Workshop on Virtual and Augmented Reality 2009
- Convert 4 sensor values to 3D normalized vector
- Map 3D vector to acceleration or speed
  - Most test subjects had fewer problems steering when controlling speed, but about half preferred controlling acceleration
    - Acceleration control eliminates need to lean while moving
- Difficult to stand still