Designing 3D User Interfaces

Lecture #13: 3DUI Design

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Thus far...

- 3DUI hardware
  - input
  - output
- Universal 3DUI tasks
  - navigation
  - selection and manipulation
  - system control
  - symbolic input
- Simple combination of techniques and devices does not guarantee enjoyable experience

3DUI Design

- Microlevel
  - devils in the details
  - correct implementation
  - careful choice of parameters
- Macrolevel
  - strengths and limitations of human psychology/physiology
  - common sense
  - rules of thumb
- Two main strategies
  - designing for humans
  - inventing 3DUIs

Designing for Humans -- Feedback

- Feedback is critical to usable 3D interfaces
  - any information conveyed to the user on to help understand
    - the system state
    - result of operation
    - status of task
- Feedback control mechanism
- Want to have appropriate feedback levels
- Ensure compliance

Designing for Humans – Feedback in Multiple Dimensions

- Sensory dimensions
  - visual, auditory, tactile, olfactory
  - proprioceptive, kinesthetic
- Want to try to give multi-dimensional feedback
  - can be difficult due to technology (e.g., haptics)
  - sensory feedback substitution
- System-based feedback
  - Reactive – combines sensory dimensions with UI
  - Instrumental – generated by controls and tools
  - Operational – results from user actions

Designing for Humans – Compliance

- Main principle in design feedback
- Want different feedback dimensions in sync
  - maintain spatial and temporal correspondence between multiple feedback dimensions
- Feedback displacement – BAD!!!

Designing for Humans – Spatial Compliance

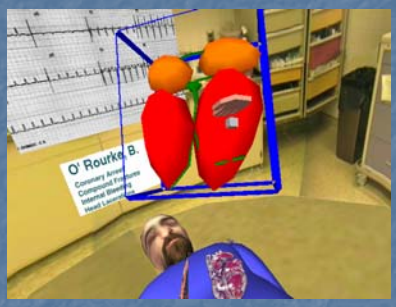
- Directional compliance – virtual object should move in the same direction as manipulated by input device
  - allows anticipatory preparation
- Nulling compliance – when user returns device to initial pose, virtual object returns to corresponding initial pose
  - helps with muscle memory
- Instrumental and operational feedback also require spatial compliance

Designing for Humans – Temporal Compliance

- Latency – typical problem
  - temporal delay between user input and sensory feedback
  - incompliance with internal feedback
- Variable latency can be even more problematic
- Solutions?
  - reduce scene complexity
  - faster hardware
  - predictive tracking

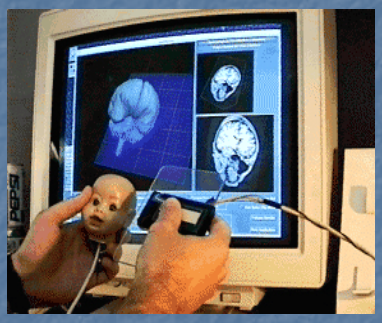
Designing for Humans – Feedback Substitution

- Cannot always support all sensory feedback dimensions
- Typical approach is to substitute



Designing for Humans – Passive Haptics

- Match shape and appearance of virtual object with physical prop
  - users both sees and feels
- Advantages
  - inexpensive haptic/tactile feedback
  - establish perceptual frame of reference
- Disadvantages
  - scalability
  - questionable performance improvements



Designing for Humans – Constraints

- Relation between variables that must be satisfied
- Geometrical coherence
  - application more important than implementation
- Want to make interaction simpler and improve accuracy

Designing for Humans – Constraint Types

- Physically realistic constraints
  - collision detection and avoidance
  - gravity
  - application dependent
- DOF reduction
  - simplify interaction
- Dynamic alignment tools
  - grids, guiding surfaces, etc...
- Intelligent constraints
  - deal with semantics

Designing for Humans – Two Handed Control

- Also known as bimanual input
- Transfer everyday manipulation experiences to 3DUI
- Can increase user performance on certain tasks
- Active topic of research

Designing for Humans – Guiard's Framework

- Tasks are
  - unimanual
  - bimanual symmetric
    - synchronous
    - asynchronous
  - bimanual asymmetric (cooperative)
- Asymmetric labor (hand roles)
  - Nondominant hand dynamically adjusts spatial frame of reference for dominant hand
  - Dominant hand produces precision movements/nondominant hand performs gross manipulation
  - Manipulation is initiated by nondominant hand

Designing for Humans – Different User Groups

- Age
- Prior 3DUI experience
- Physical characteristics
- Perceptual, cognitive, motor capabilities

Designing for Humans – User Comfort

- Weight of equipment
- Keep users in proper physical space
- Public systems sanitary
- Design for short sessions

Next Class

- 3DUI Design – Creating 3DUIs
- Readings
  - 3DUI Book – Chapter 10, 311-330