

Designing 3D User Interfaces

Lecture #13: 3DUI Design

Spring 2009

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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

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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

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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

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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!!!

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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

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Designing for Humans – Temporal Compliance

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

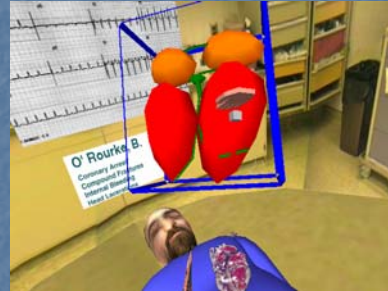
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Designing for Humans – Feedback Substitution

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



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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



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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

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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

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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

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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

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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