CSE 190:
3D User
Interaction

Lecture #17: 3D UI Evaluation

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Announcements

- Final Exam
  - Tuesday, March 19th, 11:30am-2:30pm, CSE 2154
- Sid's office hours in lab 260 this week
- CAPE
- Please return webcams, Hydras, Kinects

Paper Presentation Today

- Joey: Predator-prey vision metaphor for multi-tasking virtual environments

Final Exam

- Date: Tuesday, March 19th
- Time: 11:30am – 2:30pm
- Location: CSE 2154

Final Exam – Permitted

- Pen/pencil(s)
- Eraser/ink corrector
- Pencil sharpener
- Ruler
- Blank scrap paper

Final Exam - Not Permitted

- Cell phone (switch off)
- Other electronic devices, incl. calculator
- Books
- Lecture notes
- Cheat sheets

Final Exam - Material

- You should review:
  - Lecture slides
  - What you learned by doing the homework assignments

- You do not need to study:
  - Textbook contents not covered in class
  - Research paper presentations

Final Exam - Tips

- Similar to exams in CSE 167
- Example:
  - http://ivl.calit2.net/wiki/images/1/14/Final-fall2011.pdf
- Understand the slides
  - Use textbook as reference
  - Ask Sid in office hour
- 3D UI design task(s) possible
- No C++/OSG/OpenGL code
- Pseudocode possible

Remaining
3D UI Design Strategies

3DUI Design Strategies

- Designing for humans
  - Match design to human strengths
- Inventing 3D interaction techniques
  - Creative exploration of 3D UIs

Inventing 3D User Interfaces

- **Realism** (or isomorphism)
  - Borrowing from real world
- **Magic** (or non-isomorphism)
  - Deviating from the real world and introducing artificial, magic techniques
- Continuum between realism and magic

Inventing 3DUIs – Simulating Reality

- Tried and true approach
  - replicate world as close as possible
  - bring in certain elements
- Important for simulation applications
  - flight simulators
  - medical training
  - phobia treatment
- Dependent on application
- Advantages
  - User already knows how to do it from everyday experience
  - Can be implemented on the basis of designer intuition
- Disadvantages
  - Limitations of technology do not allow exact realism
 - Introduces limitations of the physical world into the virtual world

Inventing 3DUIs –
Adopting from the Real World

- Adopt artifacts, ideas, philosophies, domains
- Architecture and movies
- Real-world metaphors
- Examples
  - virtual vehicle
  - flashlight
  - shadows
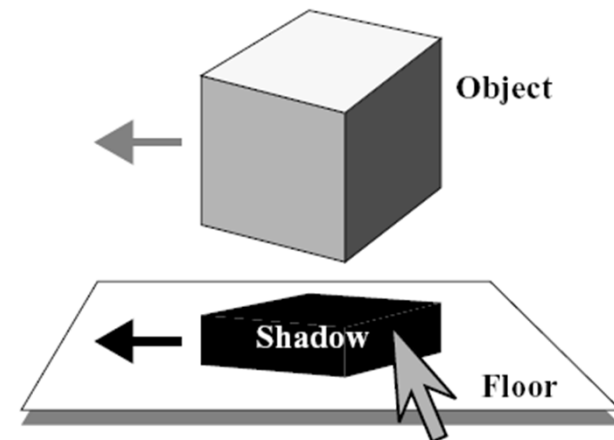
Inventing 3DUIs – Adapting from 2D

- 2D UIs studied extensively
- Most people fluent with 2D interaction
- Can be easier than 3D
- Approaches
  - 2D overlay
  - Elements in 3D environment
  - 2D interaction with 3D objects
  - UI on separate device, e.g., Ipad
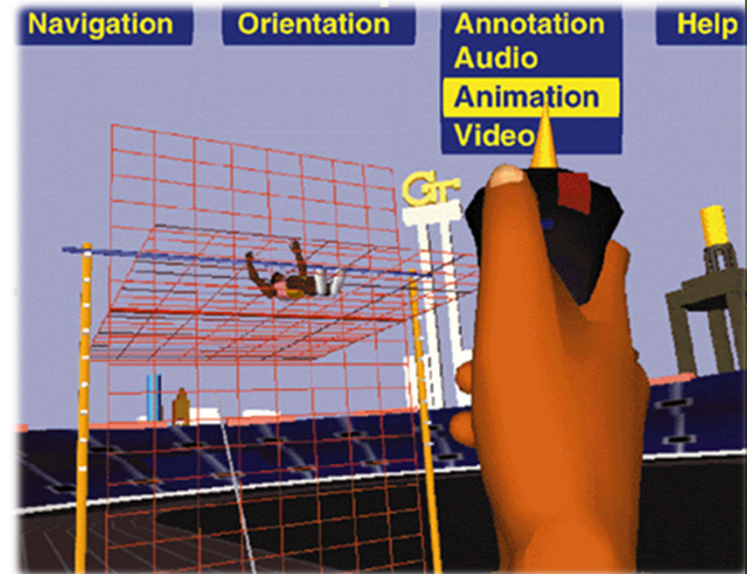
Inventing 3DUIs – Magic and Aesthetics

- Real power of 3DUIs
  - better reality
  - alternate reality
- Overcome human limitations
- Reduces effects of technological limitations

http://www.cantonmagicrafters.com/images/rabbit.jpg

Magic:
Cultural Clichés & Metaphors

- **Examples:** Flying carpet, Go-Go, WIM

- **Advantages:**
  - easy to understand if you know the metaphor
  - usually they are very enjoyable
  - many metaphors are available
  - need not to be learned

- **Disadvantages:**
  - the metaphors can be misleading
  - the metaphors are often rooted in culture
  - it is difficult to come up with good magic metaphor

3D UI Evaluation

Why User Evaluation?

- Need to compare
  - devices
  - interaction techniques
  - Applications
- Problem identification and redesign
- General usability understanding

Some Terminology

- Usability – everything about an artifact and what affects a person's use of an artifact

- Evaluator – person who designs, administers, implements, or analyzes an evaluation

- Subject – person who takes part in the evaluation

Evaluation Tools

- User task analysis
  - generates list of detailed task descriptions, sequences, user work, and information flow
- Scenarios
  - built from task analysis
  - important for experiment design
- Taxonomy
  - science of classification
  - break down techniques into components
  - used in evaluation process
- Prototyping
  - need to have something to test
  - paper-based sketches
  - Wizard of Oz approach

Evaluation Methods

- Cognitive walkthrough
- Heuristic evaluation
- Formative evaluation
  - observational user studies
  - questionnaires, interviews
- Summative evaluation
  - task-based usability evaluation
  - formal experimentation
- Questionnaires
- Interviews and Demos

Evaluation Metrics – System Performance

- System performance metrics
- Average frame rate (fps)
- Average latency / lag (msec)
- Variability in frame rate / lag
- Network delay
- Distortion

- Only important for its effects on user performance / preference
  - frame rate affects presence
  - network delay affects collaboration

Evaluation Metrics – Task Performance

- Speed / efficiency
- Accuracy
- Domain-specific metrics
  - education: learning
  - training: spatial awareness
  - design: expressiveness

Evaluation Metrics – User Preference

- Ease of use / learning
- Presence
- User comfort
- Usually subjective (measured in questionnaires, interviews)

User Comfort

- Simulator sickness
  - Kennedy - Simulator Sickness Questionnaire (SSQ)
- Aftereffects of VE exposure
  - Stanney 1998: Aftereffects from virtual environment exposure: How long do they last?
- Arm/hand strain
- Eye strain

3D Usability Evaluation

Things to Consider

Formality of Evaluation

- <u>Formal</u>: independent & dependent variables, statistical analysis, strict adherence to procedure, hold constant all other variables, usually done to compare multiple techniques or at the end of the design process

- <u>Informal</u>: looser procedure, often more qualitative, subject comments very important, looking for broad usability issues, usually done during the design process to inform redesign

What is Being Evaluated?

- Application:
  - Prototype - consider fidelity, scope, form
  - Complete working system
  - Controlled experiments are rare
- Interaction techniques / UI metaphors
  - Can still evaluate a prototype
  - More generic context of use
  - Formal experiments more often used
- Consider "Wizard of Oz" evaluation

Subjects / Participants

- How many?
- What backgrounds?
  - technical vs. non-technical
  - expert vs. novice VE users
  - domain experts vs. general population
- What age range?
- Recruiting
  - flyers
  - email/listservs/newsgroups
  - psychology dept.
  - CS classes

Number of Evaluators

- Multiple evaluators often needed for 3DUI evaluations
- Roles
  - cable wrangler
  - software controller
  - note taker
  - timer
  - behavior observer
  - …

Procedure

- Welcome
- Informed consent
- Demographic/background questionnaire
- Pre-testing
- Familiarize with equipment
- Exploration time with interface
- Tasks
- Questionnaires / post-testing
- Interviews

Pilot Testing

- Pilot testing should be used to:
  - "debug" your procedure
  - identify variables that can be dropped from the experiment

Instructions

- How much to tell the subject about purpose of experiment?
- How much to tell the subject about how to use the interface?
- Always tell the subject what they should try to optimize in their behavior.
- If using think-aloud protocol, you will have to remind them many times.
- If using trackers, you will have to help users "learn" to move their heads, feet, and bodies – it doesn't come naturally to many people.
- Remind subjects you are NOT testing THEM, but the interface.

Formal Experiment Issues

- Choosing independent variables
- Choosing dependent variables
- Controlling (holding constant) other variables
- Within- vs. between-subjects design
- Counterbalancing order of conditions
- Full factorial or partial designs

Independent Variables

- Main variable of interest (e.g. interaction technique)
- Secondary variables
  - task characteristics
  - environment characteristics
  - system characteristics
  - user characteristics

Metrics (dependent variables)

- Task performance time
- Task errors
- User comfort (subjective ratings)
- Observations of behavior (e.g. strategies)
- Spoken subject comments (e.g. preferences)
- Surveys/questionnaires
- Interviews

Data Analysis

- Averages (means) of quantitative metrics
- Counts of errors, behaviors
- Correlate data to demographics
- Analysis of variance (ANOVA)
- Post Hoc analysis (t-tests)
- Visual analysis of trends (esp. learning)

- *Interactions between variables* are often important
- Expect high variance in 3DUI interaction studies
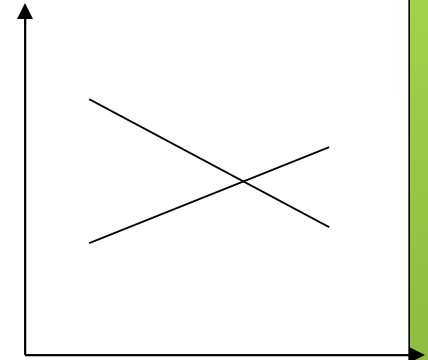
Analysis Tools

- SPSS, SAS, etc.
  - full statistical analysis packages
  - parametric and non-parametric tests
  - test correction mechanisms (e.g., Bonferroni)
- Excel
  - basic aggregation of data
  - Correlations
  - confidence intervals
  - graphs
- Matlab, Mathematica