Building Novel Web3D User Interfaces – A Case Study from Architecture and Structural Engineering

Nicholas F. Polys, Ph.D., Felipe Bacim, Mehdi Setareh, Ph.D., Brett Jones, Ph.D.,
Virginia Tech
Terminology

• 3D interaction – performing user actions in three dimensions
  – May need to be accomplished by lower degree of freedom input devices (e.g. mouse, touchscreen)

• Interaction Technique (IT) – a method for accomplishing a task
  – E.g. mapping device events to application actions
Interaction Techniques

System Software

User interface software

Input devices

Output devices

User

ITs
Universal interaction tasks

• Navigation
  – Travel – motor component
  – Wayfinding – cognitive component

• Selection

• Manipulation

• System Control

• Symbolic Input
SAFAS: Structure and Form Analysis System

- Design, simulate and analyze structural forms
- Interactive 3D client (Xj3D), simulation server
- Iterative development over 4 semesters and 200 undergraduates
Server and Data Communication

[Diagram showing the flow between SAFAS Client, SAFAS Server, CGI Form, Apache, Queue Manager, and SAP2000.]

- Authentication + SAP Input File from SAFAS Client.
- SAFAS Server inputs CGI Form.
- If authenticated, write file to user folder: `.htdocs /user1 /user2 /user3 ...`
- If there is a new file, run SAP2000.
- SAP Output File from SAFAS Server.
- Apache process.
- Queue Manager: Write SAP Output to user directory: `.queue.txt`
2D GUI: form-driven generation of structures (Swing)
‘Custom’ Navigation

• One bound Viewpoint; type=‘NONE’

• 2D Mouse events used for interaction techniques:
  – Right button Click and Drag for orbiting (reverse from Xj3D native Examine) and constrained to stay above ground
  – Scroll wheel Zooms along ray of cursor
‘Custom’ Selection

2D Mouse events used for interaction techniques:

- Left button Click checks for selectable objects
- Left button Click and Drag creates a 2D box on the image plane and selects all objects within the frustum
- Selection is compounding and can be cleared with ‘esc’
Manipulation

• Morphing structural networks with proxy deformers:
  – Domes
  – Cylinders (oriented vaults)
  – Custom Functions
• Click and Drag for manual displacement (can be constrained by axis) or set numerically
SAFAS

An example structure resulting from morphing manipulation
Simulation Results: Member Force
Comparing Two Designs

File "Pavilion 1"

Member 390:
- Area: 2.36 square in.
- Stress: 14500 psi
- Force: 34217 lb

File "Untitled-08.21.2012_09.16.47.AM"
Immersive Venue

• Stereo rendering on large projection display –
• Head tracking adds a Transform above the Viewpoint for navigation events and the Viewpoint uses the Head tracking
• MVC made this transition relatively easy
3DUI Summary

- Controller listens to 2D mouse and 6DOF head tracking events
- Multiple Selection and Undo implemented in Controller
- X3D SAI sufficient for View component of MVC pattern
- How to stay open for interaction events in future?
Thank You!

• Questions?

• Download SAFAS & request account for simulator:
  – http://legacy.caus.vt.edu/setareh/archresearch/
  – http://legacy.caus.vt.edu/setareh/archresearch/Module_2/index.html