3D User Interfaces

and

Augmented Reality
Applications

- Mechanical CAD
- 3D Animation
- Virtual Environments
- Scientific Visualization
Mechanical CAD

- Component design
- Assembly testing
- Mechanical properties analysis
- eg AutoCAD, Catia
3D Animation

- Entertainment
- Web sites
- Training
- eg alias|Wavefront, 3d studio, SoftImage
Virtual Environments

- Design
- Entertainment
- Training
- Education
Scientific Visualization

- Human imaging data
- Scalar and vector fields
  - The weather
  - Fluid flow
  - Light distribution
  - Temperature
3D Desktop?
Microsoft’s Task Gallery project

http://research.microsoft.com/ui/TaskGallery/index.htm
Some videos

- Microsoft’s Task Gallery Video
  - video
- Another 3D desktop interface
  - video
Other 3D interfaces

- Using Virtual Reality for 3D interaction
  - video
**Input/Output Devices for 3D UI**

- Display device examples
  - Head mounted displays (HMDs)
  - CAVEs (Cave Automatic Virtual Environment)
  - Tiled wall display
  - Virtual retinal display
Input Devices

- Data gloves, pinch gloves
- 3D Mouse
Universal 3D interaction tasks

- Navigation: moving in the scene
- Selection: picking an object from a set
- Manipulation: modifying object properties
- System control: changing global system state
Modification with pen and tablet
Strategies in 3D UI design

- Re-using existing 3D UI components
- Using human factors principles
- Inventing 3D interfaces
- Experiments, taxonomies
Evaluation in 3D UI

• How 3D UI evaluation is different?

• Physical issues
  • User can’t see physical world in HMD
  • Think-aloud and speech incompatible

• Evaluator issues
  • Evaluator can break presence
  • Multiple evaluators usually needed
Evaluation in 3D UI

• **User issues**
  • Very few expert users
  • Evaluations must include rest breaks to avoid possible sickness

• **Evaluation type issues**
  • Lack of heuristics/guidelines
  • Choosing independent variables is difficult
When is a 3D UI successful?

- Users’ goals are realized
- User tasks done better, easier, or faster
- Users are not frustrated
- Users are not uncomfortable
Augmented Reality

Goals
Technology
What is Augmented Reality?

- A combination of a real scene viewed by a user and a virtual scene generated by a computer that augments the scene with additional information.
What is the Goal of AR?

• To enhance a person’s performance and perception of the world

• But, what is the ultimate goal???
The Ultimate Goal of AR

• Create a system such that no user CANNOT tell the difference between the real world and the virtual augmentation of it.
Augmented Reality vs. Virtual Reality

Augmented Reality

• System augments the real world scene
• User maintains a sense of presence in real world
• Needs a mechanism to combine virtual and real worlds

Virtual Reality:

• Totally immersive environment
• Visual senses are under control of system (sometimes aural and proprioceptive senses too)
Miligram coined the term “Augmented Virtuality” to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects.
Miligram’s Taxonomy for Mixed Reality Displays

- **Reproduction Fidelity** – quality of computer generated imagery
- **Extent of Presence Metaphor** – level of immersion of the user within the displayed scene
- **Extent of World Knowledge** – knowledge of relationship between frames of reference for the real world, the camera viewing it, and the user
Combining the Real and Virtual Worlds

We need:

- Precise models
- Locations and optical properties of the viewer (or camera) and the display
- Calibration of all devices
- To combine all local coordinate systems centered on the devices and the objects in the scene in a global coordinate system
Combining the Real and Virtual Worlds (cont)

- Register models of all 3D objects of interest with their counterparts in the scene
- Track the objects over time when the user moves and interacts with the scene
Combining the Real and Virtual Worlds (cont)
Conversational agents in AR
Example videos

• Augmented reality in a kitchen
  • video

• Augmented reality for outdoor video gaming
  • video
Realistic Merging

Requires:

- Objects to behave in physically plausible manners when manipulated
- Occlusion
- Collision detection
- Shadows

**All of this requires a very detailed description of the physical scene**
Components of an Augmented Reality System
Research Activities

• Develop methods to register the two distinct sets of images and keep them registered in real-time
  • New work in this area has started to use computer vision techniques

• Develop new display technologies for merging the two images
Performance Issues

Augmented Reality systems are expected:
• To run in real-time so that the user can move around freely in the environment
• Show a properly rendered augmented image

Therefore, two performance criteria are placed on the system:
• Update rate for generating the augmenting image
• Accuracy of the registration of the real and virtual image
Limitations for Updating the Generated Images

• Must be at 10 times/second
• More photorealistic graphics rendering
• Current technology does not support fully lit, shaded and ray-traced images of complex scenes
Failures in Registration

Failures in registration due to:

- **Noise**
  - Position and pose of camera with respect to the real scene
  - Fluctuations of values while the system is running
- **Time delays**
  - In calculating the camera position
  - In calculating the correct alignment of the graphics camera
Display Technologies

- Monitor Based
- Head Mounted Displays:
  - Video see-through
  - Optical see-through
Monitor Based Augmented Reality

- Simplest available
- Little feeling of being immersed in environment
Video see-through HMD
Video Composition for Video see-through HMD

- Chroma-keying
  - Used for special effects
  - Background of computer graphics images is set to a specific color
  - Combining step replaces all colored areas with corresponding parts from video

- Depth Information
  - Combine real and virtual images by a pixel-by-pixel depth comparison
Advantages of Video see-through HMD

- Flexibility in composition strategies
- Wide field of view
- Real and virtual view delays can be matched
Advantages of Optical see-through HMD

- Simplicity
- Resolution
- No eye offset
Applications

- Medical
- Entertainment
- Military Training
- Engineering Design
- Robotics and Telerobotics

- Manufacturing, Maintenance, and Repair
- Consumer Design
- Hazard Detection
- Audio
Assignment #7 (Reading #6)

- A Study on the Manipulation of 2D Objects in a Projector/Camera–Based Augmented Reality Environment
  by Voida et al.
- Appeared in ACM CHI 2005