Topics in Virtual Reality
3D User Interfaces

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New Directions in 3D UIs

- Few fundamentally new techniques and metaphors for 3D interaction have been discovered in recent years.
- In Virtual Reality applications, users need good interface that conducts interactions.
- 3D real world acquires 3D user interfaces (3D UIs) to supply better virtual environment.
- What direction should designers follow or keep in exploring an improved 3D UIs?
Definition of 3D UIs

- 3D interaction does not necessarily mean that 3D input devices are used.
- A User Interface involves 3D interaction can be defined as a 3D UI.
- For example, 2D mouse input being translated into a 3D location and thus 3D interaction has occurred.
Categories of 3D UIs

- Desktop computing
- Virtual environments
- Augmented reality
- Large-screen displays
- Ubiquitous / pervasive computing
Facts of 3D Uls

- Limitations of the technological intermediaries and different efficiency or practicality on different applications result in difficult building up of these interfaces.

- However, interfaces to VR are supposed to be "NATURAL"
History from VR Perspective

- Many of the most basic techniques for the universal 3D interaction tasks have been discovered and implemented so far
Lack of Research Boom

- May be that there are fundamental techniques that have still not been invented
- Results of research may not have reached developers or vice versa
- Not treated with commercial benefits
- The technique alone is not sufficient to ensure usability
- What follows is to discover what other types of knowledge are needed about 3D UIs
Design Issues

- Still facing low usability of 3D UIs in real world applications
- So, new research directions will be on the concepts of: *specificity, flavors, implementation, emerging technologies*
Research Agenda

- Increasing specificity in 3D UI design
- Adding, modifying, or tweaking 3D interaction techniques to produce flavors
- Addressing the implementation issues for 3D UIs
- Applying 3D UIs to emerging technologies
Specificity

- Existing 3D interaction techniques do not provide sufficient usability in applications because of the over-generality
  - Application-generality
  - Domain-generality
  - Task-generality
  - Device-generality
  - User-generality
Flavors

- Usability can be improved by adding features or complexity to one of the basic techniques.
- Tradeoff between the level of simplicity of a basic technique and the power of a flavored technique is not clear for designers.
- Also leading to difficult implementation issues.
- Example: SSWIM (Scaled Scrolling World-in-Miniature).
Implementation of 3D UIs

- Most techniques are implemented using existing VE, AR or 3D graphics toolkits without standard library of 3D UI components available.

- Factors that make 3D UI implementation problematic:
  - A great amount and variety of input data
  - No standard input or display devices
  - Some input data must be processed before it is useful
  - Require multimodal input and produce multimodal output
  - Real-time responses
  - Continuous, parallel, or overlapping 3D interactions
Emerging Technologies

- Technological changes stimulate additional 3D UI research
- These technologies such as large-display technology, wide-area tracking technology and pervasive computing provide opportunities for future 3D UI research
- Example: 3D input
Conclusion

- Four research directions mentioned above will have a major positive impact on redesigning 3D UIs.
- Not all possible directions are covered - still many possibilities can be tried.
- What mentioned here is as a starting point for 3D UI researchers looking for new challenges.
Introduction to 3D UI Design

- VE hardware devices on user interaction, techniques for generic 3D tasks and the use of traditional 2D interaction styles in 3D environments

- User interaction tasks can be divided into:
  - Navigation
  - Selection/manipulation
  - System control

- All VR interactions need the use of devices, including input and output devices
Output Device

- Commonly, use the term **DISPLAY** to describe output

- Output including:
  - visual, auditory, haptic, tactile and olfactory
  - some semi-immersive displays, allowing the user to see both the physical and virtual world

- Allowing the user to touch and feel in the virtual world can be extremely powerful, especially for object manipulation and collision detection
Input Device

- In general, many different interaction techniques can be mapped onto a given input device.
- How naturally, efficiently, and appropriately a given input device will work with the given technique?

Categorized as:

- discrete-input device
- continuous-input device
- combination/hybrid-input device (EX. ring mouse)
- and speech input device
Navigation

- The most prevalent user action in 3D VE, supports spatial awareness, provides efficient and comfortable movement between distant locations, makes navigation lightweight
- Tasks categories: Exploration, Search, Maneuvering
- Physical movement, Viewpoint manipulation, Steering, Target-based travel and Route planning
Selection

- Object selection, positioning and rotation in VE
- Virtual hand technique and some extension of it had been widely used
- Details in Rob’s presentation
System Control

- Refers to a task in which a command is applied to change either the state of the system or the mode of the interaction

- Categorized into:
  - graphical menus
  - voice commands
  - gestural interaction
  - tools
  - or hybrid combination of above
2D Interaction in 3D VEs

- Interaction design space of a pure 3D VEs is not only utilized in 3D interface.

- Most efficient selection techniques are essentially 2D, although further manipulation requires a 3D interaction technique.

- 2D/3D interfaces can be classified into:
  - Fully immersive displays, like HMD
  - Semi-immersive displays, such as workbenches
  - Separate 2D display surfaces, like pen-based tablet
Philosophy

Artistic Philosophy

- 3D interface design should start on existing research on human factors, then reuse techniques developed by researchers; moreover, employ creativity and approaches as well as use existing design models.

Systematic Philosophy

- A study of user tasks, interaction techniques, characteristics of user, environment and system that affect performance.
- Classification is important.
- Evaluation of a design results in changes to that one, which can again be evaluated.
3D interaction research continues as VEs grows rapidly

Some principles are good for statement:

- Consider “magic” interfaces in place of “natural” ones
- Choose techniques based on the requirement
- Limit required DOF whenever possible
- Take advantage of the whole-body input, multimodal I/O, novel inputs, etc.
Unanswered Question

- Will a **standard** for 3D interfaces ever be practical?
- How do interaction change between different displays? (like, between a HMD and CAVE)
- How to determine which 3D interaction technique work best for a given application?
- How do various 3D interaction styles affect the sense of presence?