An Evaluation of 3D Positioning Techniques for Scene Assembly

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Introduction

- Study of 3D positioning techniques
- "Smart" 3D movement algorithm
- VR and non-VR technologies

Movement Techniques

Comparison of 3 Techniques

- **SESAME[1]:** 2DOF technique using the mouse. See Fig. 1 & 4.

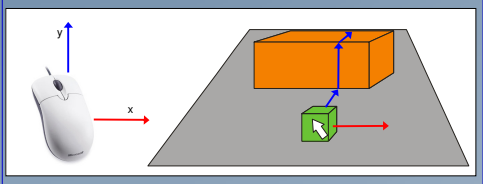

Figure 1 – SESAME sliding technique.

- **WandSlide:** 6DOF wand and "ray-casting" paradigm to drive SESAME algorithm, see Fig. 2.

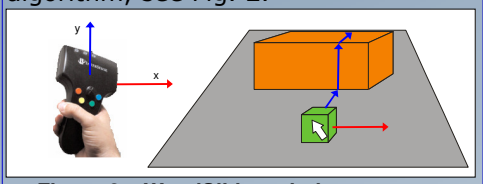

Figure 2 – WandSlide technique.

- **Wand3D:** 6DOF wand with direct 3D movement, no collision detection or gravity, see Fig. 3.

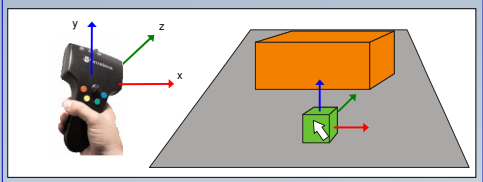

Figure 3 – Wand3D 3DOF technique.

Observation: all objects in the real world are connected to other objects. SESAME sliding emulates this by considering all surfaces behind moving object [1].

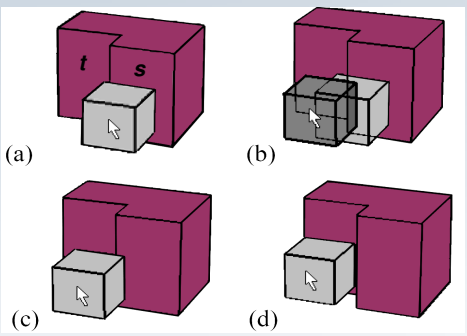

Figure 4 –The SESAME sliding algorithm. [1]

Object slides then on foremost occluded surface. See surface s in Fig 4(b) & (c).

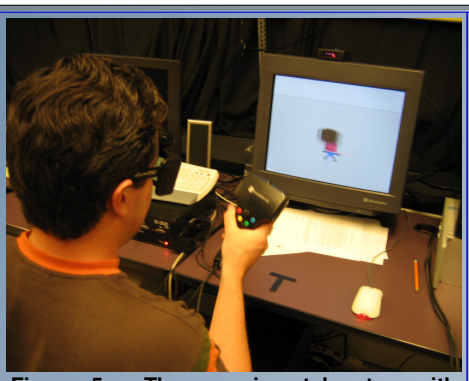

Figure 5 – The experimental setup with Intersense IS900.

Display Conditions

Display mode may also affect interaction. We compared:

- **Mono vs. Stereo:** via shutter glasses and stereo monitor.
- **Fixed View vs. Head-coupled Perspective:** via 3D tracker mounted on shutter glasses.

Experiment

12 participants, 3x2x2x2 design

- 3 movement techniques described above
- Stereo vs. mono
- Fixed view vs. head-tracked view
- 2 scene assembly tasks (Fig. 6 and Fig. 7)
- Counterbalanced via Latin square
- Participants asked to complete scene assembly task as quickly and accurately as possible.

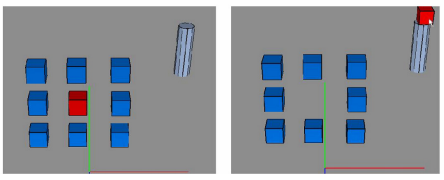

Figure 6 – Start and target scene for cube placement task.

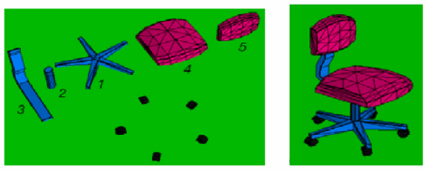

Figure 7 – Start and target scene for chair assembly task.

Results

Measured task completion time and accuracy (sum of error distance).

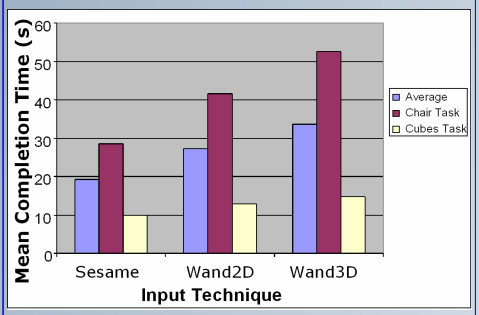

Figure 8 – Mean completion times by movement technique and task.

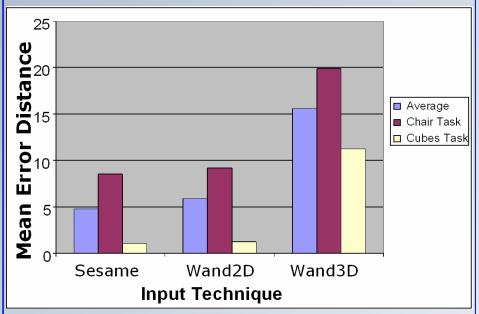

Figure 9 – Mean error distances by movement technique and task.

Significant repeated measures ANOVA results:

- Task Completion Time, $p<<.01$
- Accuracy, $p<<.01$
- Accuracy X Stereo, $p<.05$
- Task, $p<<.01$
- Interaction between Task and Movement Technique, $p<<.01$

Conclusion

- Speed and accuracy of 6DOF input devices come closer to 2D input with good algorithms.
- Minimal effects of display modes, likely due to simple scenes
- Some input devices seem better suited to certain tasks
- Future work on hybrid 2D/3D movement techniques

Reference

[1] J.-Y. Oh, W. Stuerzlinger. Moving Objects with 2D Input Devices in CAD Systems and Desktop Virtual Environments. Graphics Interface 2005, 195-202.