Design and Evaluation of 3D Multiple Object Selection Techniques

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1 Introduction

Much research on 3D user interfaces has dealt with designing techniques for interacting with one object at a time [Bowman et al. 2004]. In the past these one-at-a-time techniques have been sufficient as previous Virtual Environments contained relatively few objects with which to interact. Emerging domains, such as interior design and architecture, work with environments that contain many more manipulable objects than environments in previous applications. More powerful methods of interaction are required in these domains for users to remain productive.

Multiple object interaction techniques allow one operation to be performed on multiple objects at one time. To begin interacting with multiple objects they must first be selected. Previous multiple object selection (MOS) techniques add objects to the selected set one-at-a-time. With these *serial* selection techniques, selection of large groups of objects can be very time consuming. *Parallel* MOS techniques, such as 2D brushes and lassos, are very effective at reducing the time to select groups of objects on desktop environments and many of these metaphors can be extended to create 3D MOS techniques.

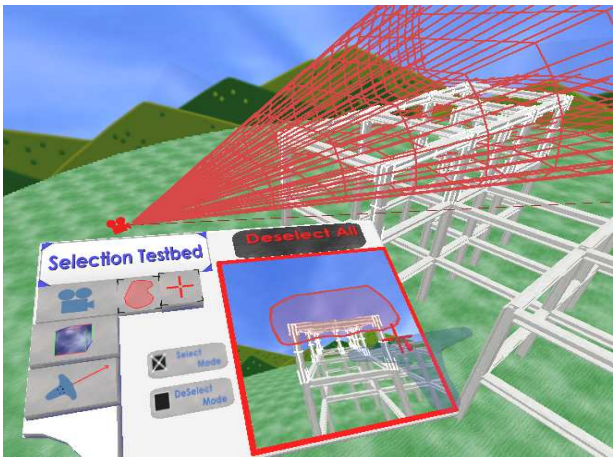

Figure 1. Tablet Freehand Lasso Technique

2 MOS Techniques

We implemented four techniques for selecting multiple objects in immersive VEs. The first two techniques selected objects serially while the second two selected multiple objects in parallel. **Ray-casting** [Mine 95] has been shown to be efficient for selecting objects from a distance with good accuracy and is easily adapted for MOS. **Tablet Tapping** made use of the Pen and Tablet metaphor [Angus and Sowrizal 1995] to interact through the separate views of the environment. A tracked plexiglass tablet provided a hard physical surface on which to extend 2D interaction techniques into 3D. The view of a remote camera object was mapped onto the user's tablet and allowed users to select objects one-at-a-time by tapping them with the 3D pointer. With the **Selection Box** technique the user constrains a 3D box directly in the environment using 3D input. Objects intersecting or surrounded by the box are added to the selected set. The box is positioned using the HOMER technique and the size is adjusted using a novel resize technique called PORT. Our fourth technique, the **Tablet Freehand Lasso Tool** (Figure 1) is derived a technique commonly used in 2D image editing software the freehand lasso. This technique allows the user to draw an arbitrary shape on the camera view screen which is then projected into the environment to create a 3D volume. As with the selection box technique, objects intersecting or within this volume are selected.

3 Evaluation

We performed two user studies to refine our MOS technique designs and to develop an understanding of how to evaluate this new class of techniques. The experiments were conducted with 24 participants in a head mounted display based system. In the experiments the participants selected objects in a variety of conditions with all four techniques.

We found that under optimal conditions participants were able to use parallel techniques to select large sets of objects significantly faster than they could with serial techniques. We also found no effect of spatial context in our results. This indicates that neither 3D nor tablet techniques were superior for this MOS task.

4 Conclusions and Future Work

3D multiple object selection is an important and relatively unexplored interaction task. In our research, we have designed novel techniques for 3D MOS, developed a taxonomy to represent the design space for these techniques, and used the taxonomy as a framework for evaluating the techniques both formally and informally. Asking whether to use serial or parallel MOS techniques in an application is the wrong question. The important question is whether to use parallel techniques *in addition* to serial techniques. Under the right conditions adding parallel selection techniques to an application could greatly speed up selection tasks. We have presented a first look at the task of 3D multiple object selection with the hope that it will inspire future work in designing multiple object interaction techniques for immersive environments.

References

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