

Efficient 3D Pointing Selection in Cluttered Virtual Environments

how accuracy between eye and hand pointing in a cluster of objects (when objects are hidden behind the other)

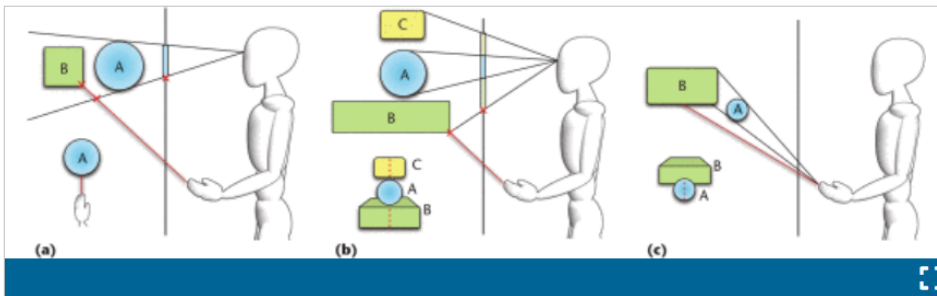


Figure 2.

(a) A situation where the user can select an object hidden by another object. (b) A visible object can't be selected because it can't be reached by a ray emanating from the user's hand. (c) Object **A** is visible from both the eye position **E**: and the hand position **H** but no point on its boundary is simultaneously visible from **E** and **H**.

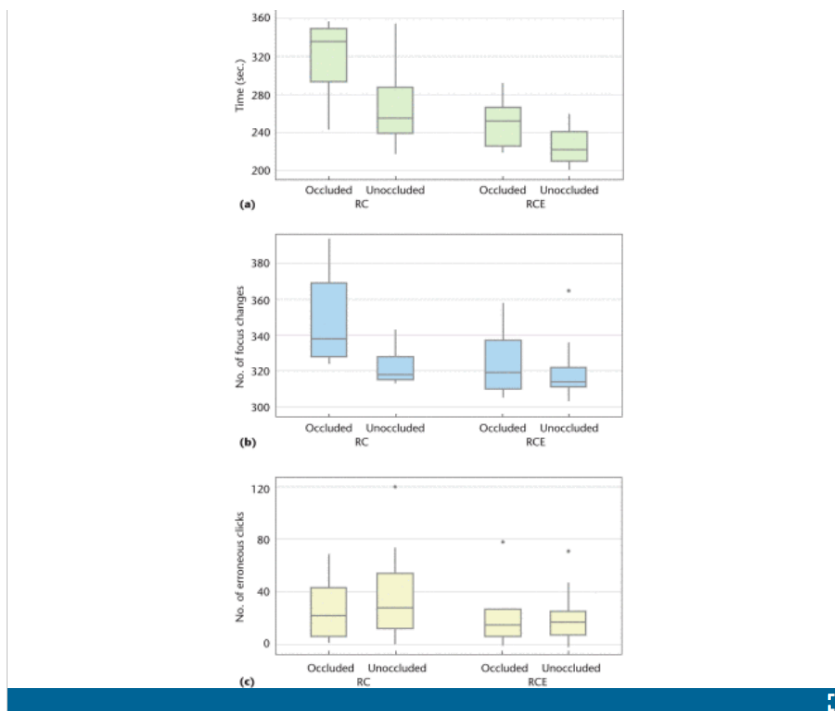


Figure 6.

The performance of ray casting (RC) and ray casting with the eye (RCE) on the occluded and unoccluded test models: (a) time, (b) focus changes (the number of times the target object changed its selection status before confirming its selection), and (c) erroneous clicks. The selection technique and the test model had a significant impact on time and focus changes, but not on erroneous clicks.

Towards a General Model for Selection in Virtual Environments

Different techniques for object selection in virtual environment, listed some properties that a technique should have, provide example situations that are tricky for one or more techniques

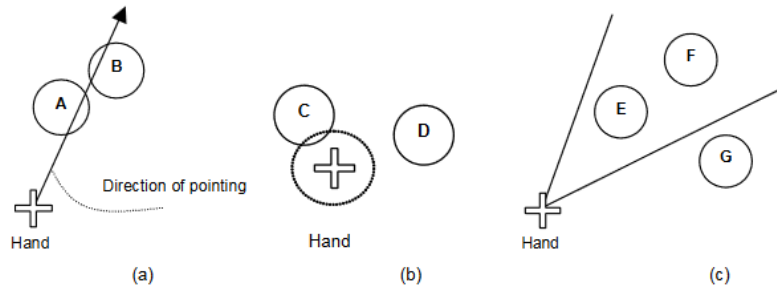


Figure 1. Simple selection techniques (a) Ray-based selection is effected by choosing first object to intersect the ray from the hand (Object A in this case) (b) Small Volume Selection is effected by choosing ever object's volumes intersect the volume attached to the hand (Object C). (c) Cone Selection can be effected by choosing all objects that lie within the cone (Objects E and F).

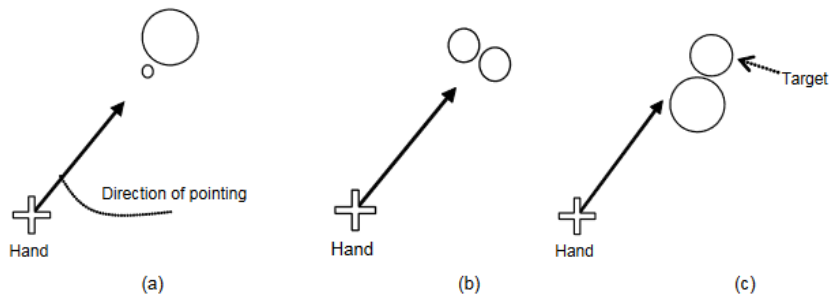


Figure 2. Some difficult cases for selection techniques (a) Small object in front of a much larger object (b) Two objects which are very close together (c) Selecting an object that is partially occluded.

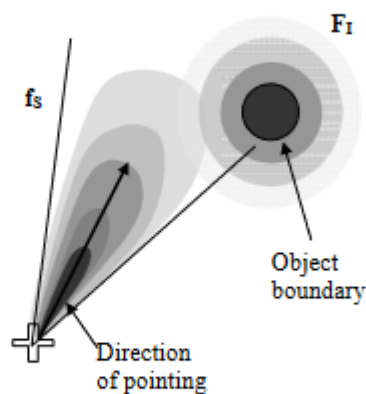
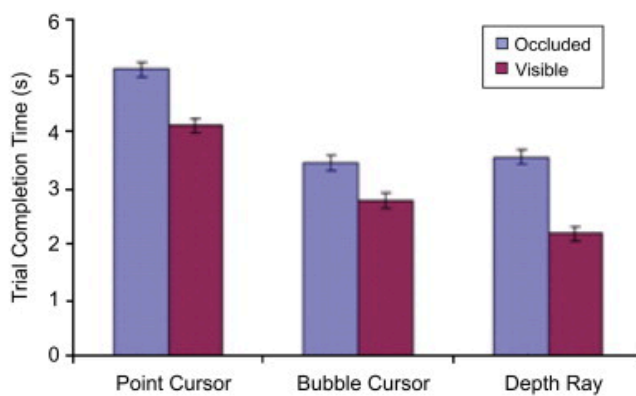
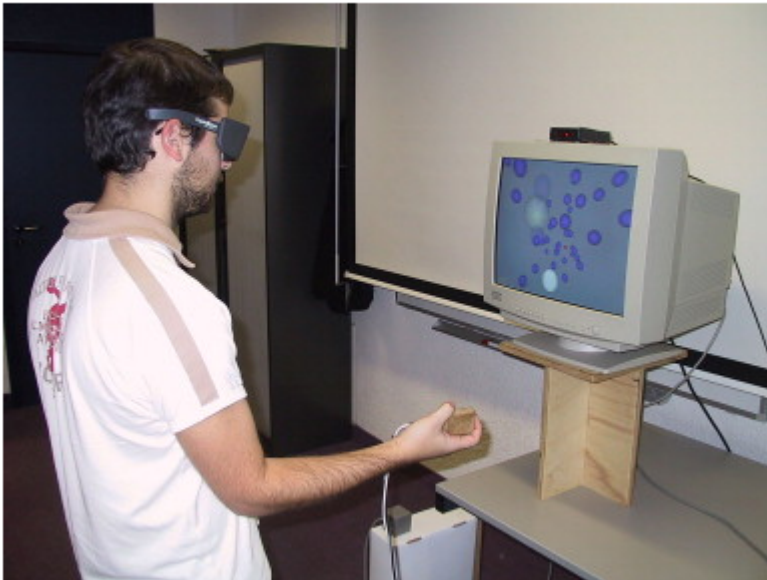


Figure 6. Enhanced cone selection. f_s is the selection field. f_i is the influence field

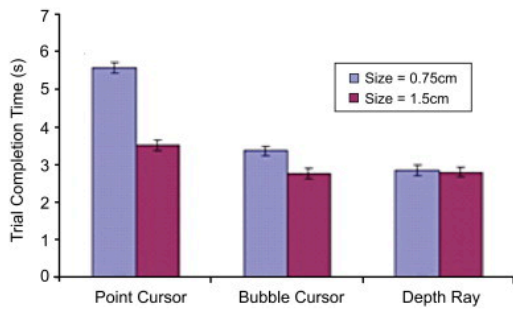
Multimodal selection techniques for dense and occluded 3D virtual environments

Compare point cursor, bubble cursor, depth ray in different situations: density, visibility, target size, size and density spacing. Experiment with desktop monitor.



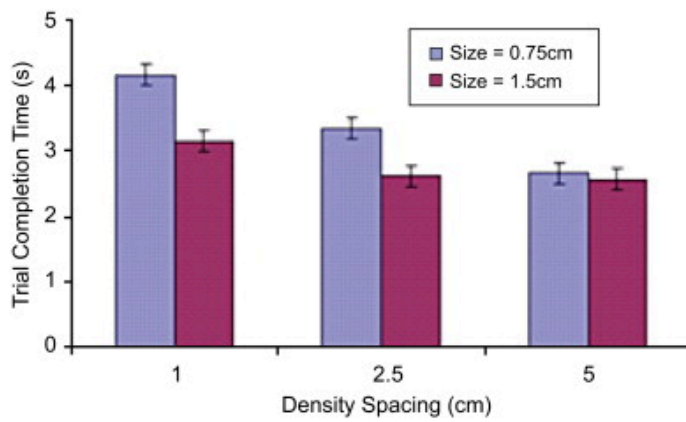
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Fig. 9. Technique completion times by visibility condition.



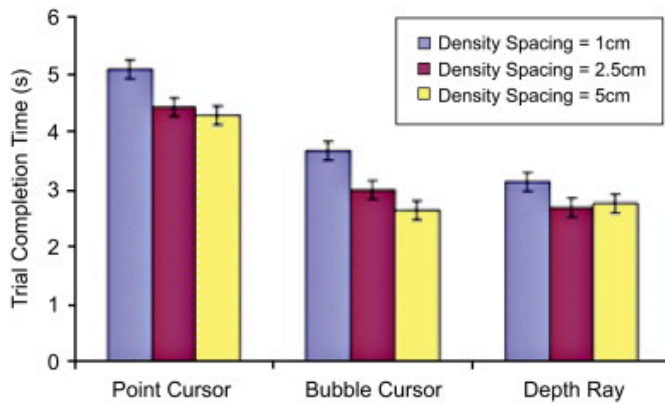
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Fig. 10. Technique completion times by target size.



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Fig. 11. Bubble cursor times by size and density spacing.



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Fig. 8. Technique completion times by density.

An evaluation of menu properties and pointing techniques in a projection-based VR environment

Compare hand pointing techniques with respect to breadth (number of menu items) and depth (top-level and child menus); menu layout pie and linear

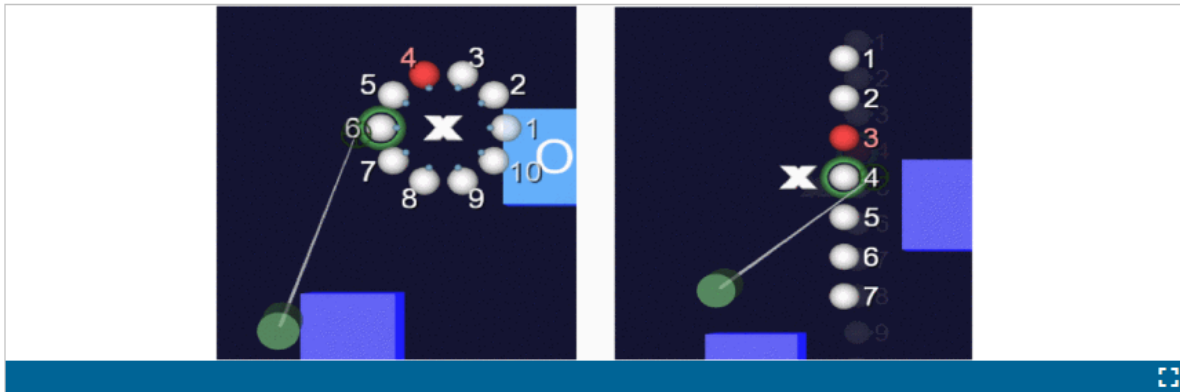


Figure 1. Menu Layouts: (a) Pie; (b) Vertical List.

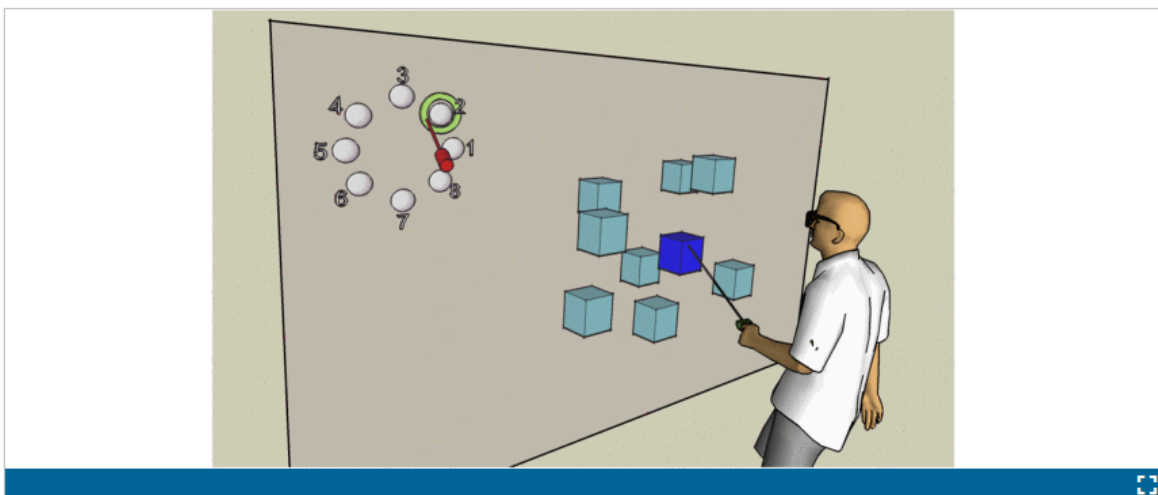


Figure 2. Experiment interface concept and world-fixed pie menu with PAM (red pointer on left). Boxes are experiment targets.

3D Marking menu selection with freehand gestures

Compare different menu layout and selection time, user experiment on tv and active glasses (for 3D immerse)

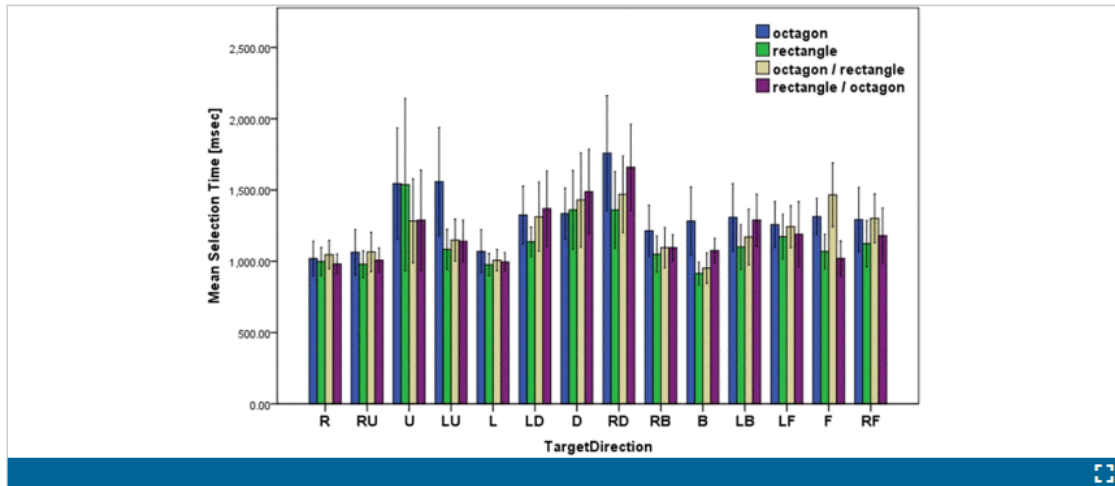


Figure 4. Selection time for marking menu layout x TargetDirection.

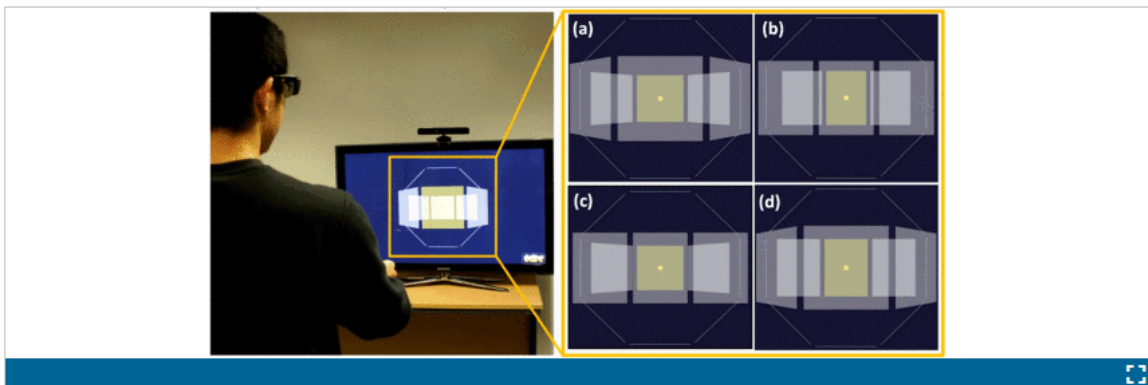
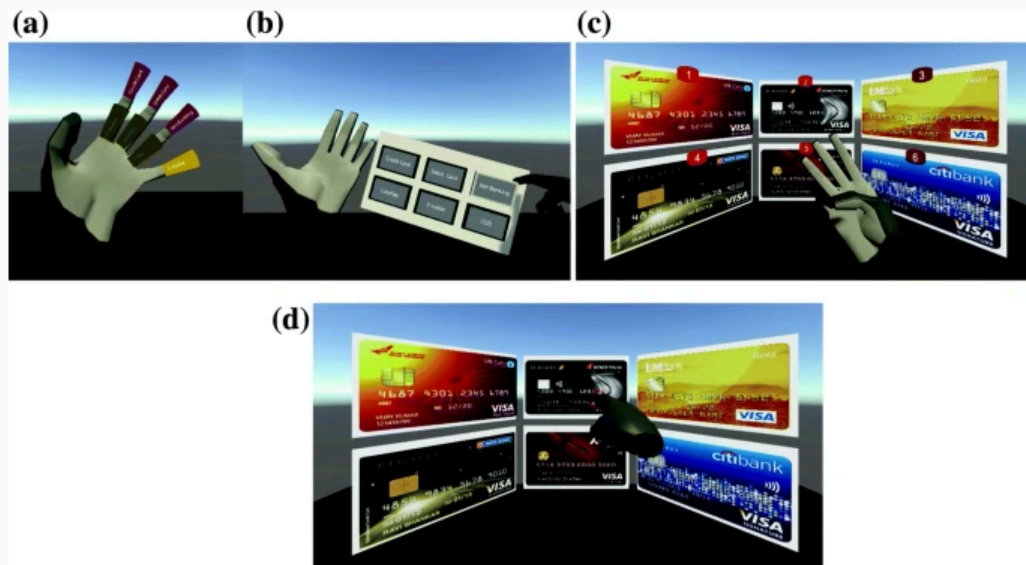


Figure 3. Experimental setting and snapshots of the 3D marking menus. (a) Octagon (b) Rectangle (c) Octagon/Rectangle (d) Rectangle/Octagon.

Exploring 3D Interactions for Number Entry and Menu Selection in Virtual Reality Environment

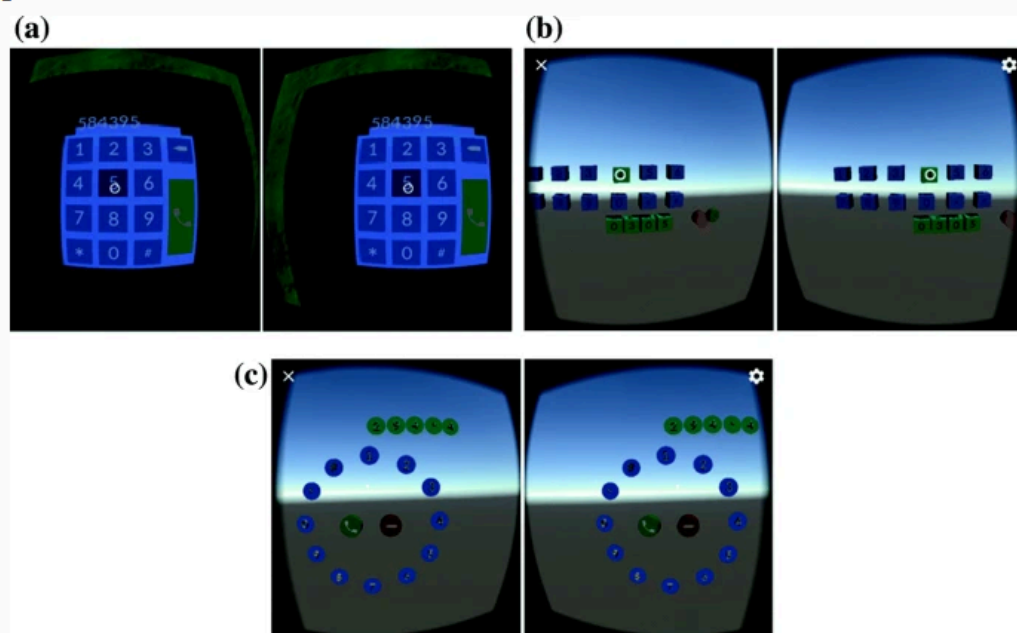
Try out menu layout techniques used in 2D in 3D env

Fig. 66.2



From left to right—**a** body-referenced menu in HG interface, **b** body-referenced menu in NOI interface, **c** world-referenced menu in HG interface and **d** world-referenced menu in NOI interface

Fig. 66.1



From left to right—**a** 2D VR keypad interface, **b** cubical VR keypad interface and **c** circular VR keypad interface