Human-Computer Interaction Laboratory

HCIL On-line Report (Virtual Environments)

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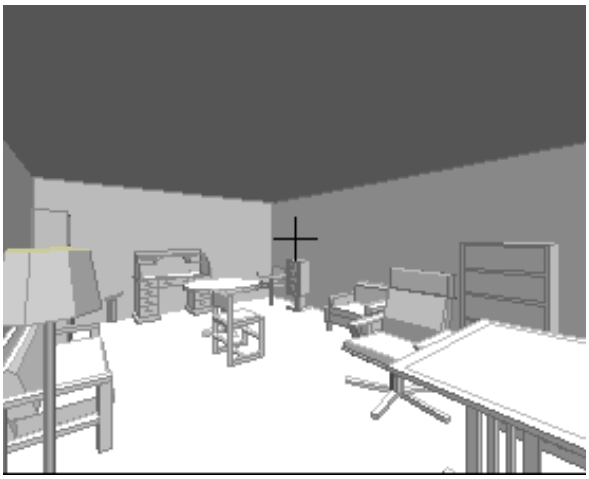
Spatial Perception in Perspective Displays as a Function of Field-Of-View and Virtual Environment Enhancements based on Visual Momentum Techniques

Increasingly, computer displays are being used as the interface "window" between complex systems and their users. In addition, it is becoming more common to see computer interfaces represented by spatial metaphors, allowing users to apply their vast prior knowledge and experience in dealing with the three-dimensional (3D) world (Wickens, 1992). Desktop VR or window on a world (WoW), as it is sometimes called, uses a conventional computer monitor to display the virtual environment (VE). The 3D display applies perspective geometry to provide the illusion of 3D space.



VE technologies offer tremendous possibilities for the future. Designers of architecture are among the first who are finding immediate use for VEs. The 3D representation of spatial information makes VEs the perfect tool for simulating architectural spaces. However, before we can use VEs effectively and reliably, a more complete understanding of the human's perceptual, cognitive, and physical capabilities must be understood. Very little research has examined whether the basic characteristics of spaces are perceived similarly in real and virtual environments.

This study investigated perceptual and cognitive issues relating to manipulations in geometric field-of-view (GFOV) in perspective displays and the effects of incorporating virtual environment enhancements in the interface based on visual momentum (VM) techniques. Systematic errors in size and distance have been shown to occur in perspective displays as the result of changes in the GFOV. Furthermore, as humans' normal FOV becomes restricted (analogous to reducing the amount of VE visible through the GFOV), their ability to acquire spatial information is reduced resulting in an incomplete formulation and representation of the visual world. The magnitude of the resulting biases increase as task difficulty increases. It was predicted that as VM increases in the interface, the ability to overcome problems associated with restricted FOVs will also increase.

Sixty participants, pre-tested for spatial ability, were required to navigate through a virtual office building while estimating space dimensions and performing spatial orientation and representation tasks. A 3 x 2 x 2 mixed-subjects design compared three levels of GFOV, two levels of VM, and two levels of Difficulty.

The results support the hypothesis that 60 degrees is the optimum GFOV for perspective displays. VM increased accuracy for space dimension estimates, reduced direction judgment errors, improved distance estimates when task difficulty was increased, improved participants' cognitive maps, and reduced the error for reconstructing the spatial layout of objects in a virtual space. The results also support the hypothesis that wider GFOVs are needed to accurately perform spatial orientation and representation tasks in virtual environments. Spatial ability was also shown to influence performance on many of the tasks in this experiment.

This study effectively demonstrates that the spatial characteristics of architectural representations in perspective displays are not always accurately perceived. There is a clear tradeoff for setting GFOV in perspective displays: A 60 degrees GFOV is necessary for perceiving the basic characteristics of space accurately; however, if spatial orientation and representation are important, a 90 degrees GFOV or larger is required. To balance this tradeoff, if symbolic enhancements are included in the virtual environment such as VM techniques, larger GFOVs are less of a concern.

Virtus WalkThrough Pro, used in this study to create the virtual environments, is a 3D, virtual environment computer-aided drawing and visualization tool for spatial design. Walkthrough Pro is an authoring application designed for use with perspective displays which provides 3D modeling. It allows the user to walk through desktop virtual environments in real-time, but dynamic interaction with objects is not supported.

The environmental stimulus in this study consisted of a simulated office building with 8 rooms connected by

several hallways and a virtual room 20 feet by 15 feet containing various pieces of office furniture.

- View a movie (4.7 meg) of the Office building or a movie (1.8 meg) of the Room

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