Proxemics and information visualization

Mikkel R. Jakobsen and Kasper Hornbæk
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Information visualization on wall-sized displays

Falko Kuester, California Institute for Telecommunications and Information Technology (Calit2), University of California, San Diego
Desktop-sized displays
Single user
Mouse and keyboard

Wall-sized displays
Multiple users
Gestures and movement
ABSTRACT
In navigating large information spaces, previous work indicates potential advantages of physical navigation (moving eyes, head, body) over virtual navigation (zooming, panning, flying). However, there is also indication of users preferring or settling into the less efficient virtual navigation. We present a study that examines these issues in the context of large, high resolution displays. The study identifies specific relationships between display size, amount of physical and virtual navigation, and user task performance. Increased physical navigation on larger displays correlates with reduced virtual navigation and improved user performance. Analyzing the differences between this study and previous results helps to identify design factors that afford and promote the use of physical navigation in the user interface.

Author Keywords
large displays, physical navigation, virtual navigation, embodied interaction.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Navigating in large virtual information spaces such as virtual environments (VEs) or visualizations can be difficult for users. Virtual navigation techniques, such as using a joystick control or pan & zoom widgets, are often disorienting and confusing. In response, information visualization researchers have developed virtual navigation aids such focus+context techniques [20]. In VEs, researchers employ wayfinding aids, but also augment virtual navigation with physical navigation (e.g. [23]).

We define physical navigation as bodily movement, such as walking, crouching, head rotation, etc., for the purpose of controlling the virtual camera that produces views of the information space. We view physical navigation as a specific type of embodied interaction [8]. Embodied interaction promotes the better use of humans' physical embodied resources such as motor memory, peripheral vision, optical flow, focal attention, and spatial memory to enhance the experience, understanding, or performance of the user.

Physical navigation is used in VEs and visualization in conjunction with a variety of display technologies such as CAVEs, head-mounted displays, projectors, wall-sized displays (e.g. Figure 1), and even desktop displays. Each of these display technologies has its own benefits and affordances for physical navigation.

Figure 1. Example large, high-resolution display being used with physical navigation.

For example, in a CAVE (a VE display made up of multiple surrounding projection screens) head tracking is used to afford physical navigation, so that users can move around (within the confines of the physical CAVE) to adjust the 3D viewpoint. Most CAVEs, however, do not completely surround the user. Head-mounted displays also use head tracking, but also offer a 360-degree surrounding view, and do not take up as much real space as a CAVE. Large, high-resolution displays allow users to see large amounts of the information at amplified scales and degrees of detail. Users can then step forward to see details (Figure 1) or step back to obtain an overview.

Promoting physical navigation to increase user performance
Ball et al., 2007
Perceptual scalability of visualization
Yost and North, 2006; Endert et al. 2011
Proximity in studies of collaboration

Jakobsen and Hornbæk, 2012; Hawkey et al., 2004
Proxemics-based interaction

Vogel and Balakrishnan, 2004

Shoemaker et al., 2010

Peck et al., 2009

Greenberg et al., 2011
Proxemics + information visualization

Data & View Specification
- Visualize, Filter,
- Sort, Derive

View Manipulation
- Select, Navigate,
- Coordinate, Organize

Process & Provenance
- Record, Annotate,
- Share, Guide

Marquardt & Greenberg, 2012
Heer & Shneiderman, 2012
Movement-based zooming and panning
Adapting a visualization to the user’s distance
Conclusion

We demonstrate single-user interaction with visualizations based on user’s distance, movement, and orientation.

Future work:

- Combine different proxemics data
- Combine with other input
- Design for multiple users
- Empirical studies