View vs. Overview

Visualizing Hierarchical Data in Desktop Virtual Reality

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1. INTRODUCTION

There is a substantial research literature on information visualization in virtual environments (Card, Mackinlay, and Shneiderman, 1999; Chen, 2000), as well as popular interest in the topic through computer games and science fiction. Virtual environments hold the promise of solving some problems facing information visualization – user disorientation, poor scalability, poor usability, and low user engagement. A variety of designs has been proposed to solve these problems (e.g., Waterworth, 1996), with an increasing amount of user testing in this area (Waller, 1999; Chen, 2000). One series of designs was developed for hierarchical data in desktop VR in the Department of Informatics at Umeå University (Modjeska, 2000). A key research issue was the trade-off between semantic and physical structures (Dillon, McKnight, & Richardson, 1993). Motivation for the research was provided by the widespread availability of desktop environments, as well as hierarchical data such as indices for the WWW.

In later research in the Department of Computer Science at the University of Toronto, an additional design was developed and tested. Previous designs in this series had featured fly-through navigation of the virtual worlds. A new prototype was added to support overview navigation of these worlds. The rest of this paper will briefly describe the design and testing of this prototype.

2. DESIGN

The earlier fly-through prototype was based on a landscape/urban metaphor for visualizing part of a Web index. The prototype was implemented in the Virtual Reality Modelling Language (VRML) for viewing in a Web browser plug-in on a standard desktop computer. (The VRML files were algorithmically generated.) User testing showed that the prototype was usable and engaging (Modjeska, 2000). A user interface (UI) problem in that design, through, was the apparent inefficiency of the third dimension.

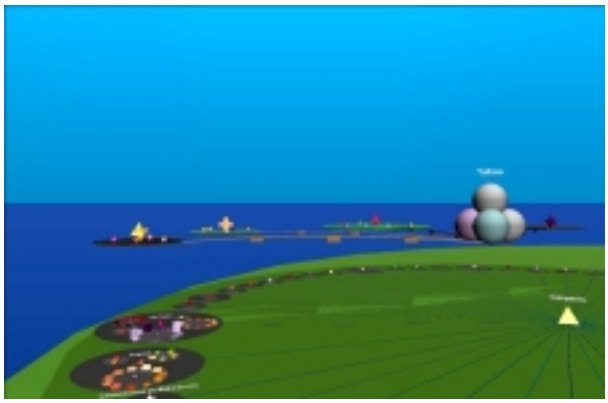

Fig. 1. A view of the fly-through design.

Accordingly, a two-dimensional map-view of the earlier virtual landscape was designed. The new prototype featured zooming and panning over the landscape from a birds-eye perspective, but the same data set was visualized. In addition, the same geometrical objects, layout algorithm, and colour palette were employed. Implementation was only a matter of modifying the world-generation software (1) to define a different user perspective and (2) to create text labels of a larger size appropriate for overview.

Fig. 2. A view of the map-view design.

3. TESTING

In order to validate the map-view design, as well as to investigate the value of the third dimension in these visualization prototypes, a formal user study was performed. As in earlier studies of the fly-through design, a search task was utilized. In order to investigate the role of individual differences, each participant was also given tests for spatial ability and structure-learning ability.

As measured by the average number of search targets found, results showed the statistically significant superiority of the map-view (13.6) over the fly-through (11.0) for task performance. This difference was confirmed by several navigational measures, such as virtual distance travelled and average proximity to target. In addition, study participants rated the map-view design as more efficient, presumably reflecting their sense of performing less cognitive work in that environment. (Detailed results for task performance, subjective ratings, and ability testing are available in Modjeska, 2000.)

Both the fly-through and map-view designs were rated as enjoyable by participants. Moreover, the participants achieved basic competence with each prototype in approximately 20 minutes of training.

4. CONCLUSION

Despite the popularity of 3D environments and the high degree of engagement that they seem to provide, empirical validation of their benefits for task performance remain elusive. For future design, perhaps a solution would be to develop a prototype that combines the engagement of fly-through with the efficiency of map-view? As VR hardware improves and decreases in cost, new possibilities will certainly arise. The study of methods to improve task efficiency and enjoyment in this domain is an exciting new area for research and development. This paper demonstrates that different desktop VR designs show significant differences in performance and enjoyment, and that the use of 3D environments may not always be beneficial.

5. REFERENCES

Card, S.K., Mackinlay, J.D., and Shneiderman, B., eds. *Readings in information visualization: Using vision to think*. San Francisco: Morgan Kaufmann, 1999.

Chen, C. *Information Visualisation and Virtual Environments*. London: Springer-Verlag, 1999.

Dillon, A., McKnight, C., and Richardson, J. "Space--the Final Chapter or Why Physical Representations Are Not Semantic Intentions." In C. McKnight, A. Dillon, and J. Richardson, eds. *Hypertext: A Psychological Perspective*. New York: Ellis Horwood, 1993, 169-192.

Modjeska, D. *Hierarchical Data Visualization in Desktop Virtual Reality*. Ph.D. thesis. University of Toronto, 2000.

Waller, D.A. *An assessment of individual differences in spatial knowledge of real and virtual environments*. Ph.D. thesis. University of Washington, USA, 1999.

Waterworth, J A, "A pattern of islands: exploring public information space in a private vehicle." In P. Brusilovsky, P. Kommers and N. Streitz, eds., *Multimedia, Hypermedia and Virtual Reality: Models, Systems, and Applications*. Lecture Notes in Computer Science. Berlin: Springer-Verlag, 1996, 266-279.

