Applying Bifocal Displays to Data Visualisation

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Ying Keung Leung

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Abstract

Rapid advances in communications and computer technologies in recent years have provided users with greater access to large volumes of data from computer-based information systems. The issue of the relatively small window through which an information space can be viewed brings with it two associated problems: presentation and navigation. This research is based on an approach called the Bifocal Display proposed by Spence and Apperley to address these inherent difficulties common in large information spaces in modern computing environments. The essence of this presentation technique is to provide the user with detailed local content as well as a global context to facilitate navigation.

In this research, the original one-dimensional Bifocal Display concept has been extended in two-dimensional form to deal with two fundamental types of large information spaces: those with a high information density, for example, large databases and spreadsheets, and those with inherent spatial relationships, such as topographic maps and networks. An experimental study has been carried out to study the usability of the Bifocal Display and other presentation techniques based on various implementations of the London Underground map. Results have shown that the Bifocal Display is a usable and effective approach for the presentation of large information spaces.

Presentation techniques can be broadly classified into distortion-oriented and non-distortion-oriented; the former generally requires more computational resources than the latter. With the increasing processing power of personal computers, researchers have developed a variety of novel distortion-oriented presentation techniques. Unfortunately, the distorting appearance resulting from the application of these techniques, coupled with the growing number of new terminologies used by researchers, has caused some confusion to the graphical user interface designer. A taxonomy of

distortion-oriented techniques based on their magnification functions has been proposed to facilitate the identification of the similarities and differences of these techniques. A conceptual model has also been put forward to unveil the underlying principles which govern their operations.

Despite the variety of novel presentation techniques currently available, the choice of a technique in a particular application remains very subjective; there is a general lack of selection guidelines or methodologies. An evaluation framework E^3 has been developed to provide a basis for the comparison of different presentation techniques, given the nature and characteristics of the data to be presented, and the interpretation required. E^3 focuses on three aspects of graphical data presentation: expressiveness, efficiency and effectiveness. This framework lays the foundation for the development of a set of metrics to facilitate an objective assessment of presentation techniques.

A general visualisation tool, the InfoLens, has been designed based on the theoretical framework of this research. The design of the InfoLens has further demonstrated that the Bifocal Display is an effective approach to visualising large information spaces.

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Publications

The following publications have been prepared in the course of this research:

1. Leung, Y.K. (1989): Human-computer interface techniques for map-based diagrams. In *Advances in Human Factors/Ergonomics* , Vol 12B: Designing and using Human-Computer Interfaces and Knowledge Based Systems, (Eds. Salvendy, G. and Smith, M.) Amsterdam, Elsevier, 361-368.

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