Chapter 7
Towards Intelligent Window Layout Management:
The Role of Mental Map

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ABSTRACT

Large displays are becoming increasingly pervasive. Larger screen size provides an opportunity for users to see more information simultaneously, but at the cost of managing a larger amount of screen space, which is a great burden declining task performance and user experience. User would do/feel better if this burden could be takeover by the computer itself employing techniques that automate the management of screen space. Some studies on automatic window management have been carried out with some success. However, they mainly focus on utilization of empty screen space and/or overlap elimination while ignore preservation of the mental map of users, which tends to cause user confusion and disorientation in practical use. In this chapter, an empirical model is proposed to identifying the degree of mental map preservation for a window layout rearrangement. Furthermore, a method combining high-level window importance with a genetic multi-objective optimization algorithm is presented to generate recommended window layouts featuring a tradeoff among several conflicting goals: (1) better usage of screen space, (2) lower degree of window overlaps, and (3) better mental map preservation. Results suggest that the method is capable of generating suitable window layouts for users and takes a key step toward developing an automated windows manager.

DOI: 10.4018/978-1-4666-8450-8.ch007

INTRODUCTION

The last decade has witnessed an unprecedented growth of information, display size and multi-task interfaces. The larger screen size provides an opportunity for users to see more information in more windows at the same time, but at the cost of managing a larger amount of screen space. For example, when using some information-intensive software such as visual analytics and stock market quotation analysis, users often need frequent window operations (i.e., *add, move, delete* and *resize*) to obtain the desired information. These operations are not relevant to the task and, as a result, drag users out of their task domain. Users' mental resources consumed by window operations make no contribution to the task performing. Additionally, when a window operation is completed, a recall process is necessary before users can return into their task context and proceed. This is quite similar to process scheduling performed by computer operating systems. Consequently, such methods of manually managing windows not only induce users' attention to be interrupted, thereby decreasing their overall task performance (Bly & Rosenberg, 1986; Bury, Davies, & Darnell, 1985; Davies, Bury, & Darnell, 1985; Johnson-Laird, 1985; Kandogan & Shneiderman, 1997; Sandberg-Diment, 1984), but also dissipate valuable mental resources. Research on automatic window layout optimization aiming to reduce the amount of needed window operations throughout the process of task performing is thus of great importance.

Improving the interaction with multi-window interfaces has been a challenge for HCI and interface researchers and some efforts have been made (Beaudouin-Lafon, 2001; Hutchings & Stasko, 2002a, 2002b, 2004; Trivedi, Lai, & Zhang, 2001). They can generally be split into two sub-categories: (1) automatically optimizing window layout, in which interfaces focus on helping users effectively utilize display space usually by maximizing visual scope and minimizing the overlap between windows, and (2) developing more efficient window operations, in which interfaces focus on considering whether the standard window operations could be improved or expanded to better help users efficiently operate the windows in the context of multi-tasks. This study lies in the former sub-category and, specifically, focuses on the integration of automatic optimization of window layout and preservation of users' mental map as well as their balance.

Some researchers (Funke, Neal, & Paul, 1993; Lüders, Ernst, & Stille, 1995; Trivedi, et al., 2001) have explored the method of automatic window layouts with some success. Nevertheless, they have rarely been adopted in practical multi-window interfaces, since most studies focus their attention on ways to better exploit empty display space and ignore the fact that the destruction of user's mental map of window layout induced by window deployment adjustment tends to cause users confusion and frustration. The term mental map refers to the structural cognitive information a user creates internally by observing the layout of the graph (Purchase, Hoggan, & Görg, 2007). This internal cognitive structure represents the user's underlying understanding of the information. Several studies (Coleman & Parker, 1996; Misue, Eades, Lai, & Sugiyama, 1995; Purchase, 1998; Purchase, et al., 2007; Purchase & Samra, 2008) have suggested that it is important for dynamic graph layout to preserve consistent mental map of users, otherwise confusion may result. For this reason, a transformation between two layouts needs to ensure that the successor resembles the previous one in order to preserve the mental map (Pilgrim, 2007). A recent study (Archambault & Purchase, 2013) reveals that users can orient themselves in dynamic data significantly easier, no matter how many targets they are tracking, with the help of mental map. Consequently, mental map preservation is useful to prevent users from getting lost in a working environment requires seeking assorted objects over time, especially when the number of which is large. Three factors had been identified in (Freire & Rodríguez, 2006) which affect mental map preservation in interactive

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