Chapter XXXIV
Navigation Support for Exploring Starfield Displays on Personal Digital Assistants

Thorsten Büring
University of Konstanz, Germany

ABSTRACT
Due to advances in hardware technologies, mobile devices are increasingly capable of handling large-scale data sets. While this development broadens the application scope of smartphones and PDAs, it also means that high information loads must be displayed on very limited screen real estate. A solution to this problem may be provided by starfield displays. Starfield displays maximize the data-pixel ratio by presenting data inside a zoomable 2-D scatterplot. However, a drawback is that once users have zoomed into the information space, they tend to become lost, due to the clipping of orientation cues. The chapter summarizes the research results of recent projects that were conducted to improve the navigation and orientation features of starfield displays on small screens. Several approaches, such as smooth zooming, overview window, and fisheye view, have been implemented and user-tested. The results may support interface designers when targeting mobile devices.

INTRODUCTION
The continuous advances in mobile hardware technology and the ubiquitous availability of wireless networks lead to novel application domains for smartphones and personal digital assistants (PDAs). While these devices were originally developed for simple personal information management (PIM) tasks, they may soon serve as a truly mobile alternative to notebooks in many business scenarios. Major software companies, such as SAP and Oracle, are already responding to this development by providing initial extensions for mobile devices. Equipped with a PDA, field sales staff can access and browse the company database to retrieve product information while being on the road.
A bottleneck that impedes the development of mobile applications, in particular for data retrieval, is the small screen size of the devices. Current mobile interfaces tend to rely on conventional list- or table-based representations that make inefficient use of screen space. Having retrieved a large number of search results, users are forced to scroll and flip pages to identify records they are interested in. Even for comparably small data sets as in the left view in Figure 1, this approach is tedious, slow, and error-prone.

A more promising interface strategy for small screens is that of starfield displays (Ahlberg & Shneiderman, 1994). Starfield displays are interactive 2-D scatterplots that rely on space-preserving encodings rather than on textual representation of data. In the desktop world, these interfaces have been found to improve the performance when searching in movie databases (Ahlberg & Shneiderman, 1994) and housing databases (Williamson & Shneiderman, 1992), or to aid drug discovery in commercial retrieval frameworks such as Spotfire (Ahlberg, 1996).

As shown in the right view in Figure 1, in a starfield display, each data object is visualized by a small symbol that is spatially mapped against two scatterplot axes of data attribute dimensions. In this way, many thousands of items can be displayed on a single PDA screen, while users are provided with an effective overview that clearly reveals clusters, trends, and statistical outliers (Tufte, 1983). The problem with scatterplots, however, is that visual clutter from overlapping items is difficult to avoid. To prune visual clutter, starfield displays allow the users to explore the information space by moving between multiple representations and viewpoints (Dix & Ellis, 1998). This interaction is based on the metaphor of a zoomable user interface (ZUI). ZUIs follow the assumption that navigation in information spaces is best supported by tapping into our natural spatial and geographical ways of thinking (Perlin & Fox, 1993). In ZUIs, data objects are organized in space and scale. Users navigate this space by performing zooming (changing the scale) and panning (movement at constant scale) operations.

Developing effective starfield displays for pen-driven mobile devices is a challenging task. In this chapter, we investigate two major aspects of the design. One is how to provide appropriate input mechanisms for controlling zoom and pan operations. On PDAs, primary input commands are limited to screen taps and a small set of hardware buttons. This places severe constraints on the interaction design. The other major design aspect deals with orientation inside the zoomable scatterplot. A general drawback with ZUIs is that, due to the clipping of orientation cues, users may eas-

Figure 1. Comparing the data-pixel ratio of a list-based search engine output and a starfield display on a PDA