PowerView:
Structured Access to Integrated Information on Small Screens

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ABSTRACT
The *PowerView* application shows how non-standard graphical user interfaces, together with the introduction of links between data of different types, can ease the interaction with digital information on small mobile devices. The information visualization technique used provides a structured and efficient way of displaying information and allows navigation using only four operators. Links between data entries further improve the system by presenting related information together, even when the data belongs to different information domains. User evaluation has shown that the system is as easy to use by novice users as systems based on well-known user interface models.

Keywords
Hand-held devices, PDA, Mobile devices, Small screens, Single-handed navigation, Information visualization

INTRODUCTION
The use of small hand-held computers, or Personal Digital Assistants (PDAs), is becoming more and more common. Having access to a wide range of information while "on the move" has proven valuable, and the technology of such devices is maturing. However, the screen size of these small devices is very limited: a PDA is typically equipped with a screen of roughly 160x160 to 240x320 pixels, about 6x6 to 6x8 centimeters in size. It is obvious that such a small display requires careful attention to interface design in order to communicate information effectively. With the increased proliferation of mobile devices, interface design for small screens is becoming an important area for HCI research. In spite of this, there has been little research on small interfaces [4]. In this paper, we present an integrated activity calendar, the *PowerView* application, which provides structured access to calendar information and allows single-handed navigation on a PDA.

POWERVIEW
PowerView is an application providing access to the most typically used information stored in PDAs, i.e. address entries, meetings, e-mail, and to-do items. PowerView has been developed for the Casio Cassiopeia E-11, which has a 240x320 pixel display that can show four shades of grey.

The interface is based on the *flip zooming* information visualization technique [3], modified to suit the given screen size. The information visualization technique allows for presentation of several independent objects and provides a moveable focus that lets the user select any object. The chosen focus is given more screen space so that more of the object's content can be displayed (see **Figure 1**). The low demand on computational power of the flip zooming technique makes it suitable for use on PDAs, and it has previously been used to show web pages on displays measuring 160x160 pixels [1].

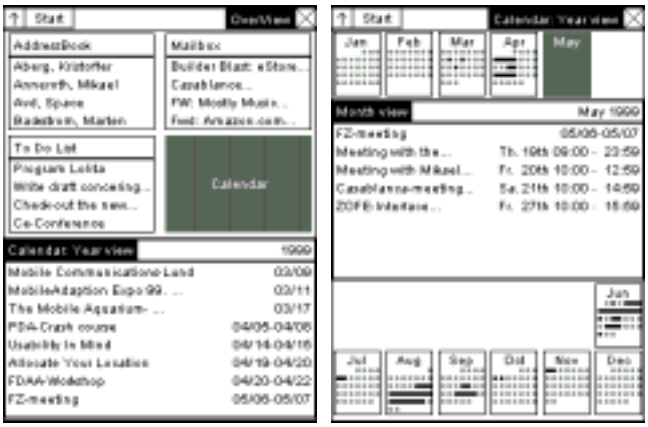

Figure 1: The PowerView application. The Overview view (left) and the Calendar view (right) are shown.

The application is built around a number of *domain views* (AddressBook, Calendar, Mailbox, To Do List), one for each information domain handled by the PDA. Each of these domain views can roughly be compared to the standard applications bundled with PDAs, but can share the display with other domain views. By having domain views as objects in the flip zooming technique, composite views are created which show several different types of information. When the application is started, the user is presented with such a composite view, the *Overview* view, which shows entries from all information domains (see **Figure 1, left**). From this view, the user can select one of the domain views and navigate the entries within that domain (see **Figure 1, right**).

In order to provide structured presentation and navigation on the small display area, the information in the domains are organized in hierarchies. These hierarchies are based on the inherent structure of the information, i.e. address entries are stored in different groups based on surname and likewise, meetings are stored in different groups depending on year, month and day. The hierarchies, however, increase the amount of navigational steps that are required to move between different data entries. This is especially true when moving from an entry of one data type to an entry of another data type, which requires that one moves from the current location to the highest level of the current information domain, changes information domain, and then moves down

Figure 2: The Context view after selecting an address book entry. The focus is on the Calendar view.

to the entry of interest. In order to mitigate this kind of navigation, some kind of connection between data entries belonging to different information domains is needed.

To facilitate navigation, we introduced *links* that go from one data entry to any other related data entries, regardless of what domain they belong to. Unlike hyperlinks, the links are not used to provide navigational shortcuts but are instead used to offer a context for any given data entry. The links enable the creation of a heterogeneous context based on the user's choice of data entry. The links can be created either by user selection when the data entries themselves are created, or can be automatically generated using methods from e.g. computational linguistics.

The contexts are used as soon as a data entry is chosen in a domain view. The data entry and its context are presented in the *context* view, which is a composite view showing all information domains but only the data entries which are linked to the selected data entry. Thus, the context aides the user by limiting the amount of data displayed and reduces the amount of navigation needed to access related information. As an example, if the user selects a person from the address book, PowerView automatically limits the information displayed to the meetings, to-do-items, and email associated with this particular person. In this way, users can move directly to relevant information without having to navigate the entire data set (see **Figure 2**).

SINGLE-HANDED USE

Since PDAs can be used in many different situations, use condition is often far from optimal. In particular, one hand might be occupied, for instance by a mobile phone, while the user tries to access some data in the PDA. For this reason, we enabled *single-handed navigation*. Like many other currently available PDAs, the Cassiopeia E-11 comes equipped with a control button on the side, the *Action Control* (see picture). This control facilitates three different types of operation: rotate up, rotate down and press inward.

Since flip zooming only needs four operators (move right, move left, select and go back), the Action Control together with the use of the *Exit* button, provide enough functionality to navigate all the data in PowerView. As the Action Control and the Exit button are located where they both are accessible by the hand holding the device, the application can be used to access information with a single hand.

USER EVALUATION

In order to evaluate the application, the PowerView interface was benchmarked against the standard application bundle in Windows CE [2]. Sixteen paid university students (10 women and 6 men, aged 17-43) were given 7 tasks to be performed on both systems in two different user situations. None had any prior experience of a PDA but all were familiar with using the Windows operating systems on stationary computers. The experiment was conducted at the Usability Lab at Ericsson Research in Kista, Sweden.

The evaluation showed that the users perceived that the arrangement of information was significantly better on the PowerView application ($F[1,15]=8.497$, $p=0.011$). Although the users received no description of the PowerView interface, no significant difference between task completion time could be found. However, none of the users utilized the single-handed navigation, despite situations where two-handed navigation led to physical discomfort (e.g. holding a mobile phone by pressing it between the shoulder and the neck).

CONCLUSIONS

The PowerView application has proved to be a viable alternative to current user interfaces on PDAs. It offers a number of advantages over these interfaces in the form of integrating the presentation of information, minimizing the navigation needed to move between related information, and enabling information retrieval by singled-handed use. The evaluation showed that the system can be self-taught in the same time as the Windows CE interface, even though the system does not build upon an already well-known user interface. However, the evaluation also showed that there were many areas of possible improvement in the system.

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