

Focus+Context Sketching on a Pocket PC

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ABSTRACT

Current Personal Digital Assistants (PDAs) such as Pocket PCs provide little support for sketching. This is due, no doubt, to the limited screen size and relatively poor resolution of these devices. To support sketching on these devices, we describe a Focus+Context technique using fisheye views integrated into a sketching application on Pocket PCs. Our technique creates a distorted display view of a canvas that is larger than a Pocket PC screen. Users draw in a high resolution focus area that is smoothly embedded into the distorted context. We have conducted a modest user trial that validates user preference for this drawing technique over a traditional scroll-bar based interface.

Categories and Subject Descriptors: H.5.2. [Information interfaces and presentation]: User Interfaces; I.3.6. [Computer Graphics] Methodologies and Techniques – Interaction Techniques; **General Terms:** Design, Human Factors.

Author Keywords

Focus plus context, Personal Digital Assistant, sketching, Pocket PC.

INTRODUCTION

Personal digital assistants, or PDAs, are popular, pervasive devices. PDAs include a suite of excellent applications for exchanging information, for organizing and scheduling, and for viewing documents. The typical input modality of a PDA is a stylus. The mental model created for the user is of a notepad and a pen. However, the applications available on a PDA are more typically computer-based applications such as calendaring, to-do lists, and even email, rather than paper-based applications such as note taking (e.g. in a meeting), brainstorming, and sketching.

In this paper, we describe a sketching application for use on PDAs. Our sketch application uses Focus+Context techniques to visualize a display surface four times the size of a PDA display. We employ a fish-eye lens to distort the display, allowing users to sketch in an area of high resolution embedded into the context while seeing the entire

display surface. We have conducted a modest user study that lends support to our hypothesis that display surface distortion is an effective method for overcoming the limited resolution of PDAs' displays for sketching application. Ongoing work seeks to test variations on Focus+Context sketching and to design a set of prototype applications to test our interface in real-world situations.

RELATED WORK

PDA-Based Note Taking and Sketching

Our interest in sketching arises from its flexibility in depicting informal information and relationships. Sketching is an interaction methodology that has proven effective for early stage design, information capture, and the depiction of physical or logical relationships between entities [1, 5, 9]. Sketches allow people to employ visual symbols, perform linguistic labeling, and describe spatial relationships. These cues serve as an aid to their own memory (stressing recognition over recall). They also serve as an aid to inter-personal communication.

Several research systems exist that explore the capture of informal, pen-based content on PDAs. These systems typically separate the input area from the view of the content of a sketch or drawing.

Davis et al. designed an informal system that supports team capture of meeting notes [4]. The system, NotePals, uses a detail-in-context technique during note capture. The user selects a location for new information from the screen, and the system highlights the insertion location. The user then enters notes at the bottom of the display.

Yee uses the technique of a virtual display space coupled with a spatially aware palmtop in the Peephole editing system [12]. The Peephole system relates physical movement of the PDA to logical movement in a virtual information space. The Peephole system can operate in an isolated mode, where the larger information space is invisible unless directly under the peephole, or in a coupled mode, where the virtual information space is displayed on an external monitor. One compelling aspect of this system is the unlimited size of the virtual information space. A drawback of this system in isolated mode is the requirement placed on the user to recall the information in the virtual display space, including his or her location. A drawback of the system in coupled mode is the requirement for constant

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refocusing, on the part of the user, between focus and context.

PebblesDraw focuses on the use of PDAs for computer supported cooperative work [10]. The touch screen on the PDA provides the user with access to a remote space. In group meetings, this remote space is viewed as a “common ground” where users of the PDAs can simultaneously post information. To visualize all the information in the remote space, users again switch focus between their PDAs and an external monitor displaying the shared information space.

Focus+Context Display

Focus+Context techniques are designed to smoothly integrate a high detail focus area and a low detail periphery. They serve to maximize display space. Ongoing work on Focus+Context techniques includes work with display distortion through fisheye views [6], bifocal displays [11], and others [2, 8].

Carpendale has condensed display distortion techniques into a unified framework [3]. Her goal has been the construction of a library, the “Elastic Presentation Space” or EPS library, that allows systems to make use of display surface distortion for the visualization of information. Researchers have studied visualization [3] and targeting [7] using her library. In our application, we make use of the EPS library to support pen-based sketching on a PDA.

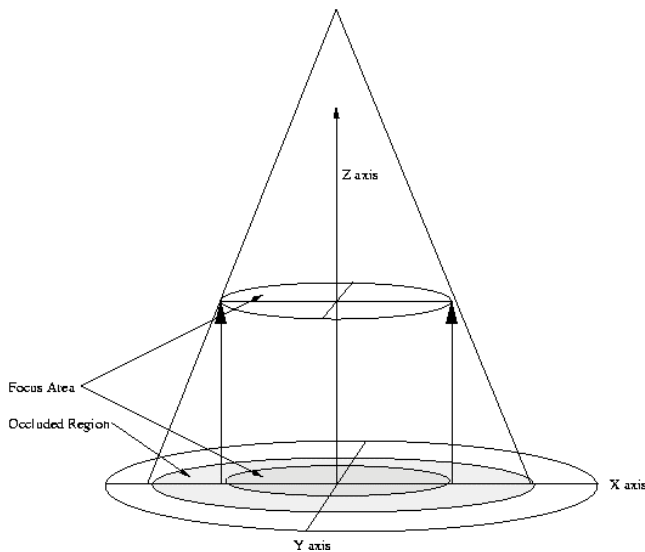


Figure 1: Carpendale's EPS library uses a three-dimensional projection of a two-dimensional image.

Carpendale's display surface distortion technique visualizes the display space as a three dimensional space in which a two dimensional display can be flexibly projected. As shown in Figure 1, the focus area of the display is raised along the Z-axis to magnify it. The context remains on the plane at the origin of the Z-axis. To avoid occluding the shaded region of the context, the context can be distorted in various ways using a “drop-off” function. Drop-off functions are polynomial curves that are used to raise points

on a base image to various heights depending on their distance from the focus location. Basically, they take the context and gradually distort it into the focus, allowing smooth embedding of the focus into the context. A complete discussion of display surface distortion and Carpendale's unified technique is beyond the scope of this paper. The interested reader is referred to [3].

DESIGN AND IMPLEMENTATION

We integrated the Carpendale's Focus+Context framework into a drawing application on Pocket PC devices. The application turns a Fisheye focus area into a high resolution input area where users can sketch free-hand content. The focus area is embedded in a movable frame that can be panned around the screen when drawing. The context information, computed using the EPS framework, is preserved around this focus area with some compression in spatial resolution. By creating a continuous transition between the two levels of detail, the application allows users to draw in higher detail on the small display surface.

Several visualizations are supported by the EPS toolkit for embedding focus into context. These visualizations employ “drop-off” functions to embed the focus area into the context area. In our application, we use a Gaussian drop-off function to distort the context around our focus window. The Gaussian drop-off function blends smoothly the focus into the distortion and the distortion into the context. We felt a smooth transition was important to avoid discontinuity in the visual effect being presented to the user. Figure 2 shows a focus region embedded into a context using the Gaussian drop-off function.

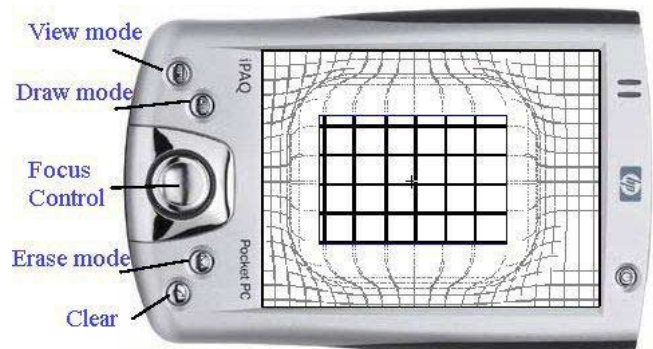


Figure 2: Gaussian drop-off function and button assignment in our sketch application.

To allow editing of images and panning around the screen, we employ a set of “quasi-modes” accessed using the Pocket PC buttons. To simplify access to the buttons, the application is implemented in “Landscape” mode on the Pocket PC (see Figure 2). In the default mode, a user draws a narrow pen stroke on the display. The top button, when pressed, allows access to a *View* mode where users can use the pen to pan the focus area around the screen without drawing marks. The *Draw* mode allows a user to draw a thicker, two-pixel pen stroke. The Rocker switch provides an alternative mechanism for moving the Focus region.

Finally, the bottom two buttons provide for an *Erase* mode and a *Clear-screen* function.

The need for real-time browsing requires constant distortion of the display surface, and frequent screen updates of both focus and context. To support real-time browsing in our application, we use two optimizations. First, we fix the focus location and pre-compute our distortion function. Second, we make use of a shareware game API library, GapiDraw, for graphics rendering on the IPAq.

Figures 3 and 4 show examples of sketches performed using our sketch application implemented on a Compaq IPAq. The application was developed under the following environment:

- Host PC: Windows 2000 Professional, eMbedded Visual C++ 3.0 SDK, and Microsoft ActiveSync 3.5.
- Embedded Device: Microsoft PocketPC 2002 OS and eMbedded Visual C++ 3.0 on the IPAQ 3600/3800/3900.
- Utility packages: EPS framework library compiled for the ARM architecture and the GapiDraw 2.05 package.

We implemented the application on three test IPAqs for our user trial. All IPAqs use the StrongARM 203Mhz microprocessor. Two were equipped with 64MB of RAM and the final one had 32MB of RAM.

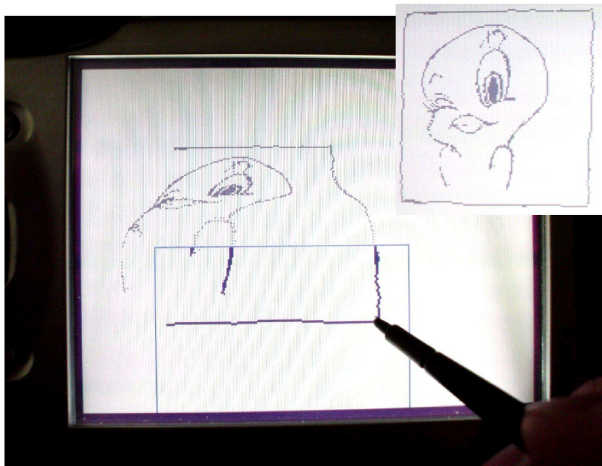


Figure 3: Distortion behavior while drawing with our sketching application.

USER TESTING

We conducted a user trial of 17 users. The users were drawn from sophomore, junior and senior students in the Computer Science Department at San Francisco State University. While computer science students are often not good subjects for a general user trial, we were, in this case, looking for users who were comfortable with PDAs. Given our difficulty in locating a sufficiently large set of PDA users, our assumption was that the substitution of students comfortable with computers would be a good alternative.

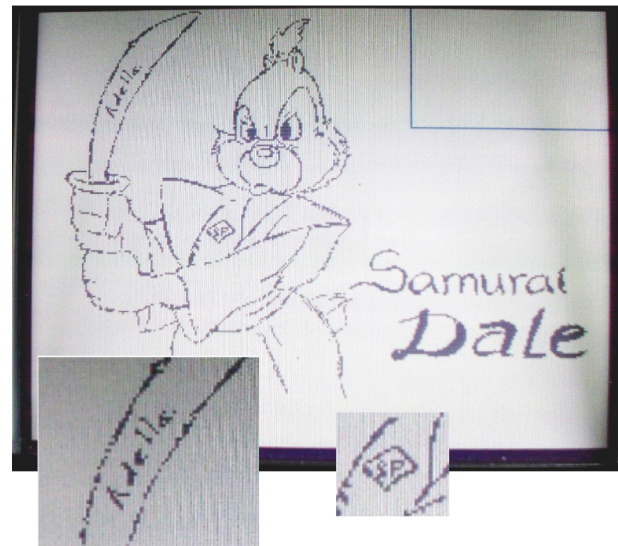


Figure 4: A sketch showing fine detail. Note the signature on the Samurai's sword and the initials on the gi.

We implemented a reference application that used scrollbars to navigate a display surface four times the size of the pocket PC screen. Users were given the same two drawing tasks with each interface, and were allowed to draw additional sketches if they wished (see Figures 3 and 4). The first task was to write or print a text passage. The second drawing task involved copying a UML diagram. Users were free to switch back and forth between interfaces as they wished. After completing the task, we administered a post-trial questionnaire.

In the questionnaire, we asked the users to respond to a series of statements on a scale of five to one (five = strongly agree, 1 = strongly disagree). The first two statements on the questionnaire tested user satisfaction with the two interfaces. The statements were:

1. I liked the scrolling interface.
2. I liked the fisheye interface.

The histogram in Figure 5 summarizes the responses to statement 1. The histogram in Figure 6 summarizes the responses to statement 2. Users appear to show a preference for the fisheye over the scrolling interface ($p = 0.024$ for a one-tail t-test with 16 degrees of freedom). The last statement on our questionnaire verifies the results of the first two responses by asking our users to respond to the statement:

- I prefer the Fisheye interface over the scrolling interface.

The histogram in Figure 7 summarizes the response to this question and confirms the preference for the fisheye interface observed from the responses to the first two statements.

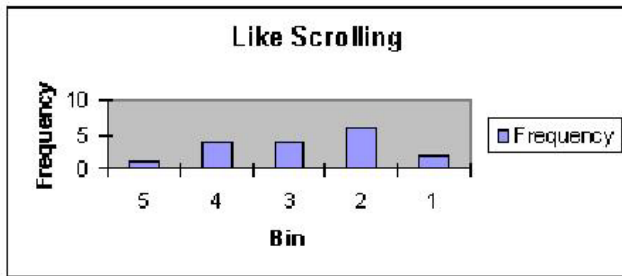


Figure 5: User agreement with the statement “I liked the Scrolling interface.”

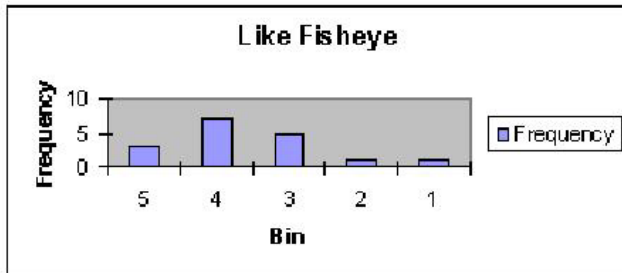


Figure 6: User agreement with the statement “I liked the Fisheye interface.”

When asked to freely comment on potential improvements to our interaction technique, users had several suggestions. Six of the seventeen users suggested some mechanism for automatic movement of the focus region while drawing. As well, two users desired some non-mode based mechanism for panning the focus region around the screen (perhaps a small region in the upper right corner of the focus region).

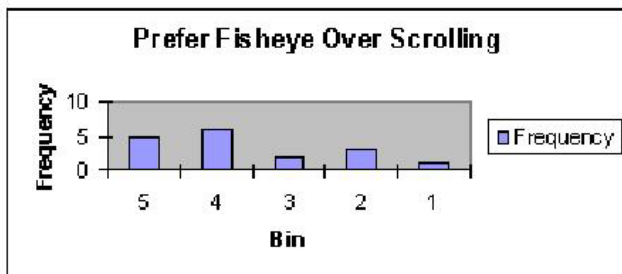


Figure 7: User agreement with the statement “I preferred the Fisheye interface over the scrolling interface.”

CONCLUSION

We present a Focus+Context technique for sketching applications on small displays. This technique allows users to sketch in a high-resolution focus area, while still seeing the focus area in context with the rest of the drawing. We describe an initial user trial that indicates a user preference for Focus+Context sketching over a standard scrolling interface.

One significant advantage of display space distortion is the ability to see the focus area and the context area on a single small display. Previous techniques either do not display context [12], or require the display of context on another monitor [10].

We continue to experiment with variations on Focus+Context sketching. First, we are exploring the effect of different magnifications on user satisfaction. Second, we are designing several more refined applications using our technique to improve validation. Finally, we continue to experiment with automated focus motion to allow more fluid drawing.

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