A Separated Focus+Context Screens System for Sketching

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ABSTRACT
Designers need a larger electronic workspace effective for sketching. To provide such a workspace, we have developed a focus+context screens system which tethers a smaller 'focus' screen to a larger 'context' screen. For increased performance and a more naturalistic interaction, we also split the input into sketching with the dominant hand and control with the non-dominant hand. We compare the differences between design work using current systems and our system. Our results and recommendations should help systems designers develop more effective separated focus+context screens systems.

Author Keywords
Design, Focus+context, Sketching, Two-handed interaction.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation (e.g., HCI): User Interfaces.

INTRODUCTION
Designers need a larger electronic workspace effective for sketching [1]. To be effective for sketching, we believe a larger electronic workspace should enable a designer to sketch on a high-resolution screen in an ergonomic and familiar manner, quickly and accurately navigate to different parts of a design, sketch details in context of the broader design, and instantaneously switch between a detailed portion of a design and its context.

To satisfy these requirements, we could use a visualization technique such as zooming [3] or a distortion-based view [4, 6, 12], or use a single large screen [5]. While each of these techniques meets some of our requirements, none of them meet all of our requirements. For example, a zooming canvas does not enable a designer to sketch details in context of the broader design and the use of a single large screen provides poor ergonomics [5].

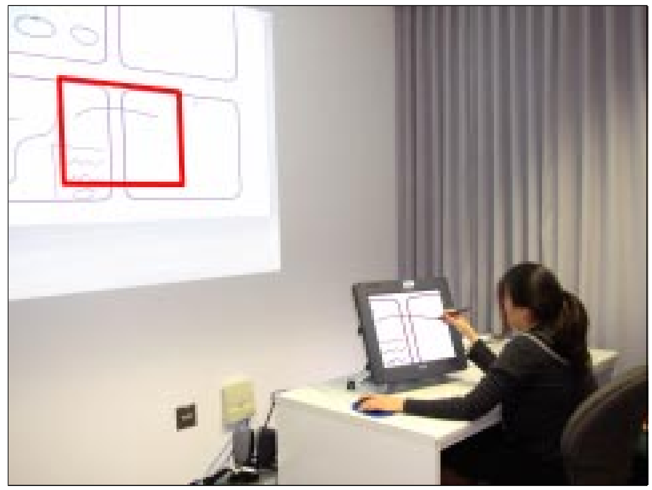

Figure 1. A user interacting with our focus+context system. She controls the frame of reference using her non-dominant hand while sketching with her dominant hand.

To create a larger electronic workspace that meets our requirements, we developed a focus+context screens system in which we tethered a high-resolution tablet to a large screen. As shown in Figure 1, the tablet provides a logical frame of reference into the content shown on the large screen.

In contrast to the focus+context screens system developed by Baudisch [2], we physically separate the focus screen from the context screen to provide a designer with a more ergonomic context view while sketching. We position the large screen just above and behind the tablet to ensure that the tablet does not block the view of the context. Since our focus screen is tied to, but physically separated from its logical frame of reference, we also gain the ability to scale the focus and context views independently.

Consistent with bimanual theory [7, 9], we enable a designer to control a focus+context screens system using a 6DOF input device in her non-dominant (ND) hand while sketching with her dominant hand.

We show how the use of our focus+context screens system overcomes the limitations of existing systems; by separating the focus and context displays into large and small screens, each screen can complement the other, creating a system more effective than its component parts. Our system allows a designer increased performance and more naturalistic input, providing him with a more effective electronic workspace for sketching.

A focus+context screens system such as ours would be useful for a wide variety of sketching applications; annotations in graphs or charts, multimedia interactions using a visual sketching language, and industrial or mechanical design, where mathematical curves can be mixed with rough sketching for color and shading, are just a few examples.

RELATED WORK

Our work differs from previous work in that we are using a focus+context screens system to provide a larger electronic workspace effective for sketching, and using a ND hand input device for control.

Larger Electronic Workspaces

To provide a virtually larger workspace, we could use a zooming canvas [3], but this does not enable a designer to view details in context of the broader design [2]. Distortion-based views [4, 6] have been effective for visualizing large amounts of information, but the inherent spatial distortion involved would be awkward and inappropriate for visual design tasks such as sketching.

To provide a physically larger workspace, we could use a large digital desk. A large digital desk, however, typically has poor resolution, is not well-suited for users under 5’6”, is not ergonomic, suffers from parallax effects, and users do not prefer it to a tablet for sketching [5].

Previous systems which tied smaller displays to a large display [13, 14] either did not support or were not designed for sketching. Baudisch et al. surrounded a high-resolution small screen with a lower-resolution large screen [2]. Since the screens lie in the same plane, however, a designer would need to sit very close to the screens to sketch, overly limiting her visual angle to see design context.

Control Techniques

Photoshop’s navigator implements a focus+context screen by providing an additional, smaller window. This competes for screen space, a precious commodity to designers [10]. Unlike our system, it does not allow the context view itself to be manipulated and there is ostensibly little empirical justification for this particular configuration of view and mapping. Most importantly, in our system, we allow a designer a more natural environment by enabling her to control the focus+context screens system using her ND hand.

Buxton has shown that two-handed interaction can enable faster performance for drawing and other tasks [9]. In our work, we investigate two-handed interaction for controlling a focus+context screens system.

FOCUS+CONTEXT SCREENS SYSTEM

To provide focus+context, we tethered a high-resolution tablet to a lower-resolution large screen where the tablet, i.e., the focus screen, provides a frame of reference into the context screen (see Figure 1). With our focus+context screens system, a designer can use the tablet for sketching and can use the larger screen to see design context.

On the context screen, we draw a frame of reference to enable a designer to quickly identify their location in the context. The focus screen shows details of the design lying within the frame of reference. We draw the frame of reference on the context screen using a red rectangle, as shown in Figure 1 (it appears dark grey if printed in greyscale).

Separated Displays

Designers traditionally prefer paper to computers for sketching, since paper affords a very tactile, high-resolution surface and is the *de facto* model for pencil or pen strokes. To mimic this interaction as closely as possible, we use a Wacom Cintiq 18SX graphics display tablet. The Cintiq allows a designer to sketch directly on the surface of the tablet with very high resolution and sensitivity, as well as the freedom to move, pivot, and reposition the display itself.

For the context screen, we use a NEC LT260 high-lumen projector to project a large screen on the wall. We position the focus screen on a desk a few feet away from the projected screen and horizontally center the focus screen with respect to the projected screen.

Our approach is similar to Baudisch’s [2], except that we physically separate the two displays to afford a wider visual angle of the context screen, which is important for improving spatial performance. To drive the focus and projected screen, we use a Macintosh computer with a dual head graphics card. We wrote the software for our focus+context screens system using Objective-C and Cocoa under Mac OS X.

Non-dominant Hand Input

Consistent with theories of bimanual input [7], we enable a designer to control the information shown on the focus screen using her non-dominant (ND) hand while sketching using a stylus in her dominant hand as shown in Figure 1. Buxton has shown that a two-handed interaction consistent with bimanual theory can provide better performance on drawing tasks than a single-handed interaction [9].

For our input device, we selected 3D Connexion’s Cadman, a 6DOF isometric input device, which we refer to as a “puck.” We chose this device because Jacob and Sibert recommend that an input device used for panning and zooming should enable a designer to perform these tasks in parallel [8], which our puck does.

Figure 2. A *zoomable interface* forces a designer to choose between a detailed view (on the left) and a less-detailed context view (on the right).

When a designer sketches on a physical sheet of paper, he uses his ND hand to position the paper, and his dominant hand to draw and erase strokes. We wanted to mirror this familiar, naturalistic interaction as closely as possible, but still allow additional controls (such as zooming) that are useful in an electronic medium.

COMPARISON WITH CURRENT SYSTEMS

In order to compare our focus+context screens system with existing systems, we have chosen a task that is typical of designers working with electronic workspaces. Our designer wants to add detail to the right eye of the face in Figure 2, using the context to position it correctly relative to the other eye, mimic the existing style, and add emotion which fits the rest of the face. This could be useful, for example, when creating or animating an interactive game character.

Electronic Workspaces

Let us compare the workflow using pencil and paper, a zoomable interface, a fisheye view, a traditional focus+context screen display, and our separated focus+context screens display, to show how our system provides a more effective sketching environment than the other tools.

- *Pencil and paper*. To add detail to a portion of a drawing, a designer simply focuses her attention on the area of interest, and proceeds to sketch. To look at the broader design she need only glance up or tilt back her head, without needing to lift her pencil. Paper, however, does not support "undo", nor does it allow for animation, multimedia, or distance collaboration.
- *Zoomable interfaces*, such as Pad++ [3], allow a designer to "zoom into" an area of focus. In order to view the broader design, however, a designer needs to switch his entire display to a different zoom factor. Thus, our designer is forced to choose between editing the details of the eye and viewing the overall context of the face, as shown in Figure 2.
- *Fisheye view*. Since a fisheye view shows surrounding details in addition to the area of interest [6], it forces a competition for screen space to balance the focus and context. Increasing space for the context limits the allowable sketching region, a precious commodity, but increasing the focus space detracts from the design's context. Additionally, the fisheye view warps the design significantly (see Figure 3). This is ineffective for our sketching task, where precise layout and structure are crucial to the visual understanding of a design.

Figure 3. A *fisheye view* causes distortion in a design, making it ineffective for sketching.

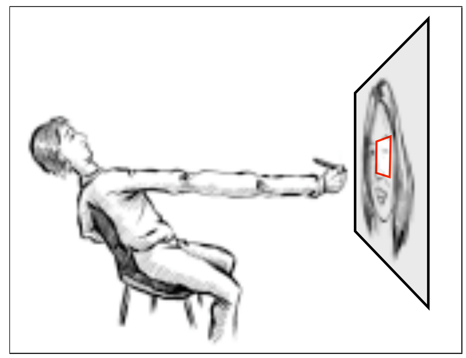

Figure 4. An *integrated focus+context screen*, with both views on the same plane, would require the designer to move farther away from the screen in order to see the context of his design.

- *Integrated Focus+context screen*. Baudisch's focus+context screen puts both displays on the same plane in physical space [2]. The high-resolution focus display is ideal for sketching tasks while up close, but in order to see the broader context, a designer must physically step back away from the display, due to its size (see Figure 4). Thus, the switch from detailed sketching to examining context could take a significant amount of time and effort.
- *Separated focus+context screens*. In our system, the designer is allowed the freedom of sketching along the entire surface of the focus view. With a glance upward, she can see the focus view in relation to the undistorted broader context of her design on the larger context screen (see Figure 5). This enables her to maximize time spent on a task while minimizing interaction effort.

Control Techniques

We compare various control techniques to our actual implementation of a 6DOF input device:

Figure 5. With a *separated focus+context screen*, the designer can work with the detailed focus screen (on the left), and with a glance see the focus view in relation to the context of the design (on the right).

- *Stylus with modes*. Most design tools today require the designer to switch tool modes – via a keypress or by holding down a button – to toggle input between sketching and control. Greater performance and satisfaction could be obtained by exploiting a ND hand's movement and its naturalistic "framing" of the sketching space [9].
- *Mouse with scroll-wheel*. We originally implemented our system using a mouse to position the virtual canvas, and the mouse's scroll wheel to zoom or scale content on the focus screen. Preliminary tests showed users found the one-to-one mapping of the mouse frustrating and tiring, especially for large movements which required repeated motions and picking up the mouse.
- *Accelerometers*. A designer could use the movement and tilt of the focus screen itself to control the display through accelerometers. While effective for palm-sized devices [11], the size and weight of the Cintiq we used was quickly determined to be ineffective for this type of control, inhibiting fine adjustments and limiting on-screen interactions to large, jerky movements.
- *6DOF Device*. A 6DOF device in the designer's ND hand allows each axis of movement and rotation to be mapped to a different control: for example, twisting the puck could zoom in and out of a design. The dominant hand is free to sketch without a modal interruption while the ND hand smoothly controls the design. This parallels the naturalistic interaction afforded by pencil and paper.

FUTURE WORK

We are in the process of evaluating different configurations of input mappings to determine the highest performing and most satisfactory. Additionally, we would like to confirm our design rationale through a formal comparison between a separated focus+context screens system, Baudisch's focus+context screen, and a zoom-able interface such as Pad++.

In our current implementation, we tie the designer's ND hand to the focus view on the projected display (the red rectangle in Figure 1): when the designer pushes left, the red rectangle moves left. This makes sense when looking at the projected display, but if the designer looks at the *focus* display while pushing left, he sees the design move to the *right*. We are currently investigating input configurations in an attempt to resolve this discrepancy of motion.

REFERENCES

1. Bailey, B., and Konstan, J. Are informal tools better? Comparing DEMAIS, pencil and paper, and authorware for early multimedia design. *CHI 03*. 313–320.
2. Baudisch, P., Good, N., and Stewart, P. Focus plus context screens: Combining display technology with visualization techniques. *UIST 2001*.
3. Bederson, B., Hollan, J., Perlin, K., Meyer, J., Bacon, D., and Furnas, G. Pad++: A zoomable graphical sketchpad for exploring alternate interface physics. *Journal of Visual Languages and Computing 7* (1996), 3–31.
4. Dee-Lucas, D., and Larkin, J. Learning from electronic texts: Effects of interactive overview for information access. *Cognition and Instruction 13(3)* (1995), 431–468.
5. Elliott, A., and Hearst, M. A comparison of the affordances of a digital desk and tablet for architectural image tasks. *IJHCS 02 56(2)* (2002), 173–197.
6. Furnas, G. Generalized fisheye views. *CHI 86*. 16–23.
7. Guiard, Y. Asymmetric division of labor in human skilled bimanual action: The kinematic chain as a model. *Motor Behavior 19(4)* (1987), 486–517.
8. Jacob, R., and Sibert, L. E. The perceptual structure of multidimensional input device selection. *CHI 92*. 211–8.
9. Kabbash, P., Buxton, W., and Sellen, A. Two-handed input in a compound task. *CHI 94*. 417–423.
10. Kurtenbach, G., Fitzmaurice, G., Baudel, T., and Buxton, B. The design of a gui paradigm based on tablets, two-hands, and transparency. *CHI 97*. 35–42.
11. Rekimoto, J. Tilting operations for small screen interfaces. *UIST 96*. 167–168.
12. Robertson, G., and Mackinlay, J. The document lens. *UIST 93*. 101–108.
13. Streitz, N., Geiüler, J., Holmer, T., Konomi, S., Müller-Tomfelde, C., Reischl, W., Rexroth, P., Seitz, P., and Steinmetz, R. i-land: An interactive landscape for creativity and innovation. *CHI 99*. 120–127.
14. Tani, M., Horita, M., Yamaashi, K., Tanikoshi, K., and Futukawa, M. Courtyard: Integrating shared overview on a large screen and per-user detail on individual screens. *CHI 94*. 44–50.