Powers of Ten Thousand: Navigating in Large Information Spaces

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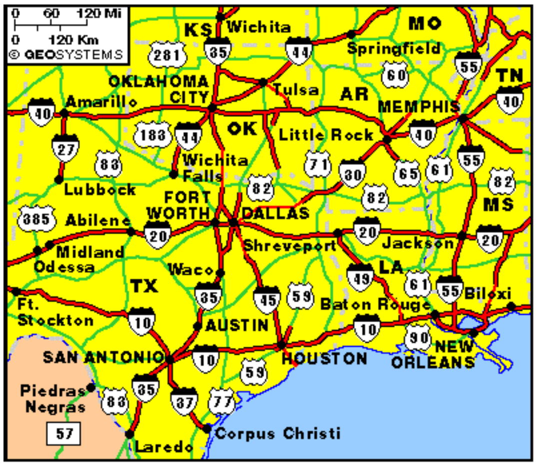
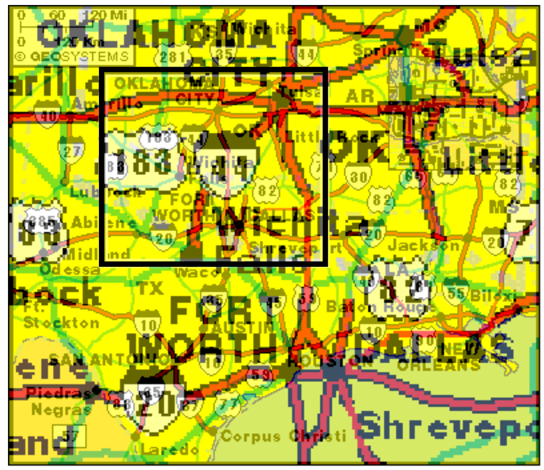




ABSTRACT

How would you interactively browse a *very* large display space, for example, a street map of the entire United States? The traditional solution is *zoom* and *pan*. But each time a zoom-in operation takes place, the context from which it came is visually lost. Sequential applications of the zoom-in and zoom-out operations may become tedious. This paper proposes an alternative technique, the *macroscope*, based on zooming and panning in multiple translucent layers. A macroscope display should comfortably permit browsing continuously on a single image, or set of images in multiple resolutions, on a scale of at least 1 to 10,000.

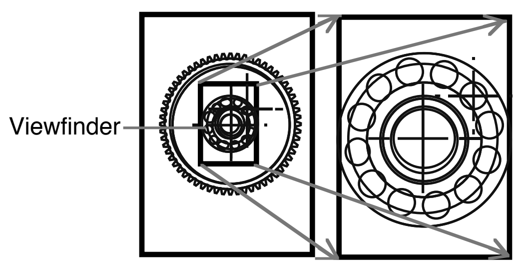
POWERS OF TEN THOUSAND

The book and film *Powers of Ten* [4] try to instill an appreciation of the scale of the physical world by a succession of images each on a scale differing from the next by factors of ten, from atomic to galactic perspectives. Each image shows the scale of the next smaller image by a rectangular viewfinder placed at its center. The power of *Powers of Ten* is that it brings together in a single work phenomena that occur over a wide range of spatial scales, and forces us to think about the relationships between them. Can we use the computer's interactivity to provide a dynamic version that goes beyond the book's static snapshots?

In this paper, I will explore a new technique, the *macroscope*, that involves taking the visual device of *Powers of Ten* and compounding it, using the computer's ability to combine, change and display images interactively

THE MACROSCOPE: TRANSLUCENT ZOOMING AND PANNING

Let's start by analyzing a typical zooming operation. The user can choose a smaller subset of the screen, which we will call the *viewfinder*. The zooming operation blows up the viewfinder to fill the entire image. A zoom out operation does the inverse transformation



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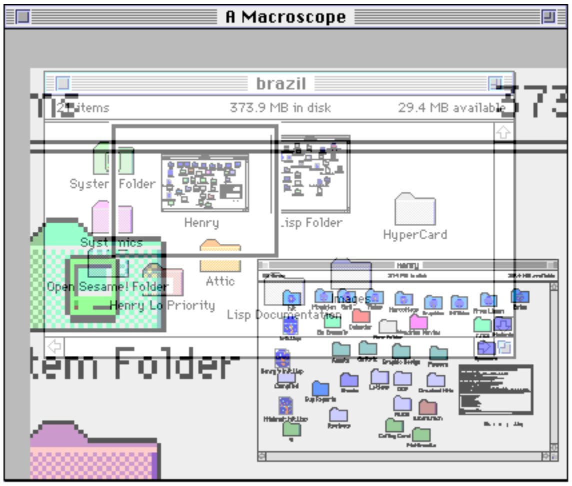
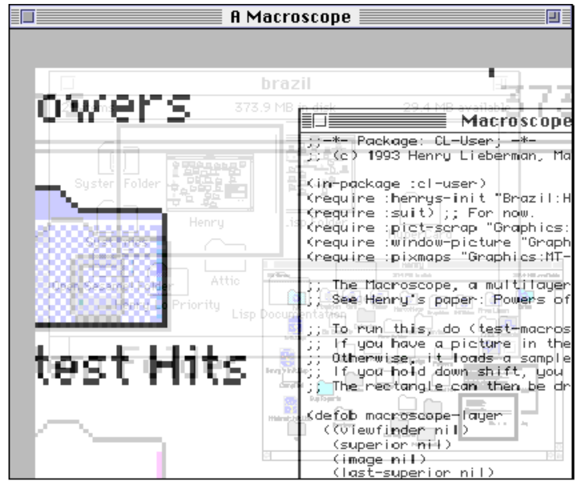
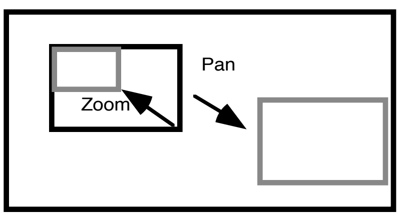
One problem with this is that after the zoom operation, the viewer loses the context of where the blown-up image came from. Our solution is to make the zoomed-in and zoomed-out views share the same physical screen space by displaying them in multiple translucent layers. Recent experiments [2] have shown that it is feasible to combine multiple layers of information on a single display, using translucency, focus and other image processing techniques





to visually combine layers while retaining the integrity of the individual components.

We start with a map of the south central US. Selecting a rectangle, we construct a two-layer macroscope that focuses in on the Oklahoma-North Texas area. Superimposed on the original map is an enlarged image of the viewfinder area. The real payoff is in interactively controlling the multiple layers. Change of position of the rectangle corresponds to a pan operation; change of size of the rectangle corresponds to a zoom operation.



The visual effect of zooming and panning is that of imagining the visible screen area as a window onto a much larger translucent virtual sheet displayed "in front of" the background. Zooming corresponds to "stretching" or "shrinking" the sheet and panning corresponds to "sliding" the sheet. While one layer is moving relative to another, the layers are much more easily distinguished.

Dynamically adjusting the translucency levels between layers, as in [2] is an key technique for selectively emphasizing or de-emphasizing information at user control. Emphasizing the background layers aids in orienting yourself in a large space; emphasizing the foreground layers gives precise control over the close-up view. Our interface is designed to allow dynamic control over the relative emphasis of layers simultaneously with the zooming and panning operations. And why stop at two layers? Above, we illustrate 2- and 3-layer macroscopes on a display of the Macintosh Finder. The lowest level shows the text of an individual file [actually, the code that displays the macroscope itself!].

RELATED WORK

Surprisingly, there has not been much work on improvements to the standard zooming and panning operations for navigating spatial information. Use of a 2D plane of spatial information with interactive control of scale was introduced in [3], and [5] is a contemporary implementation. The macroscope is a kind of *see-through interface* [1], where the "toolglass" covers the entire viewing surface. Whereas Bier et. al.'s interface uses transparent pixels in the tool image and motion of the tool to avoid obscuring the underlying image, we use true translucency to combine layers.

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