Multi-Scale Viewing

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ABSTRACT

As the ability to accumulate and generate very high resolution image data explodes so does the need for appropriate access tools. We present a multi-scale or detail in context viewing tool for image data.

Keywords Multi-scale viewing, 3D interaction

INTRODUCTION

There is an increasing amount of high resolution visual information being collected from many disparate sources including satellites and radar, as well as being generated both scientifically and artistically (for example Plate 1). While a growing library of image analysis, communication and manipulation tools make it advantageous to work with these images on computers, these tools do not include the possibility of detail in context viewing. The browsing capabilities are limited to panning, zooming and various types of insets or multiple view approaches.

The last few years have seen the development of many detail in context viewing techniques mostly applied to visual displays of information represented by discrete graphs (for surveys see [5, 9]). Essentially these techniques allow a user to magnify chosen sections to reveal the desired detail and compensate for the extra space this magnification requires by various types of distortion and/or compression in the rest of the image. Usually there is a gradual decrease in magnification as the distance from the focal section increases. The advantages attributed to these techniques include:

- Increases in the amount of information that can usefully be presented on a computer screen.
- Human preference for remembering and presenting information in this manner [3].
- Utilization of visual gestalt by retaining the perception of the information space as a single event.
- Increased user performance in path finding tasks [4, 8].

In spite of all this positive evidence there has been little extension of these techniques for use with raster or continuous images. One exception is Document Lens [6] which is limited to a single focus and text documents. The other possible exception is the morphing based approach discussed in [7] which could be used for continuous images. However, it places a limitation on size and proximity of foci both to each other and the edges of the image, allows for no roving search, and may have to be applied iteratively to get reasonable visual results.

This lack of extension may be partly due to the fact that the usual approach of applying the distortion function to each discrete piece of information does not extend well to images. However 3dps [2], which utilizes a two-dimensional surface to make distortions in a discrete information comprehensible, is a natural choice of extension into the continuous domain (Plate 2). This paper presents the extension of 3dps to raster images.

MULTI-SCALE VIEWING

3dps [2] is a multi-scale viewing tool initially developed for discrete information spaces but easily extended to continuous spaces. Its primary goal is to create understandable compression patterns while including or extending the functionality of all other detail in context viewing tools. The basic concept is that of a 2D pliable surface. The actual information is placed on this surface, which is then manipulated in 3D space. In a very analogous manner complete images can be placed on this surface as a texture. Sections of the surface can be pulled

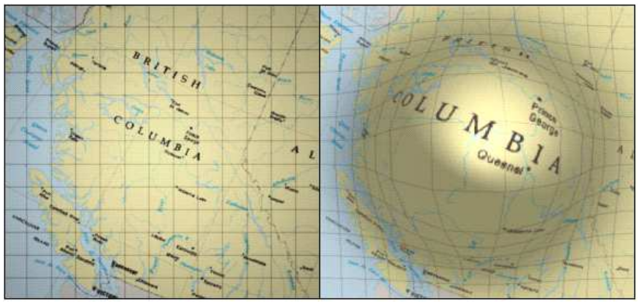

Figure 1: Map of Bristish Columbia: left undistorted, right single focus

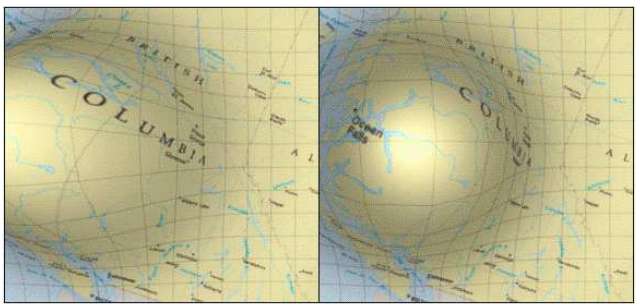

Figure 2: BC map single off-center focus: left perpendicular projection, right viewer aligned

toward the view point to magnify automatically in one-point perspective projection (Figure 1).

Multiple arbitrarily positioned foci (Figure plate 2) are aligned to the viewer. That is instead of raising focal points perpendicular to the plane, they are raised along vectors directed to the users viewpoint (Figure 2). However, since a point under multiple

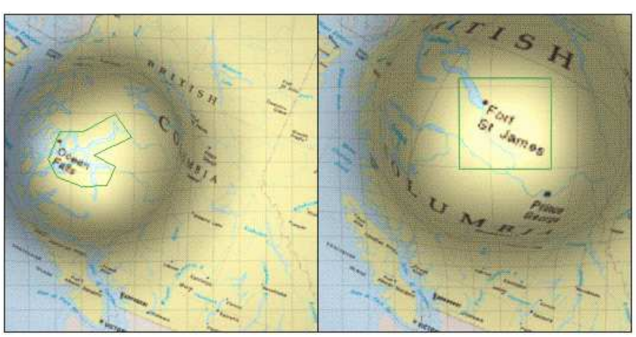

Figure 3: Arbitrary foci shapes: left concave, right convex

curves will have conflicting projection vectors (one

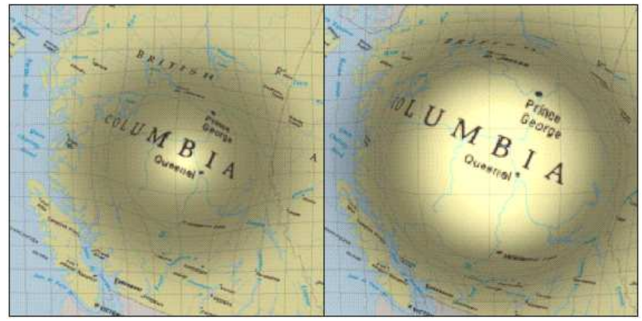

Figure 4: Varying distortion patterns

associated with each curve), simply using the vector of the highest curve can result in a discontinuity where the dominance switches from one curve to another. To prevent this buckling curves are blended [2] as follows: the displacement is the maximun perpendicular height, and the direction of this displacement the sum of all the incident curves' projection vectors.

Additional functionality includes arbitrary focal shapes (Figure 3) and distortion control (Figure 4). Since the distortions are created with mathematical curves, the pattern of relative distortion/compression can be altered by adjusting the curve's parameters or by the addition of auxiliary curves. Figure 4 shows the result of extending the degree of magnification into local context.

Visual cues are optionally added for distortion comprehension. This support allows users to maintain an accurate mental representation, learning that the information is not impaired by the distortion. At present these cues include: shading of the resulting three-dimensional form, a grid which gives an approximate quantitative reading of the distortion, and fog as a depth cue. The series in Figures 5 and 6 shows the effect of visual cues in reading multi-scale images. As shading is applied additively the topological shading of the original image of Mars (Figure 5) is still readable. Notice that it is easy to interpret the image with two foci and no visual cues as simply a different section of the surface of Mars (Figure 6). The addition of these cues help prevent a multi-scale image from miss-informing the user.

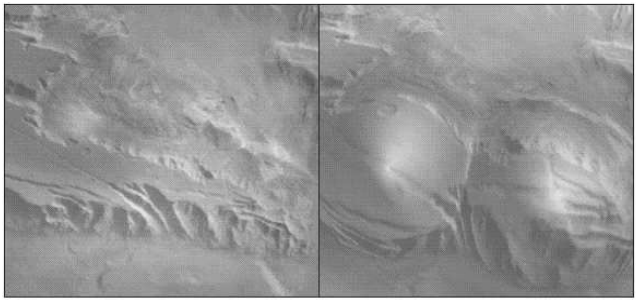

Figure 5: The surface of Mars: left undistorted, right shaded foci

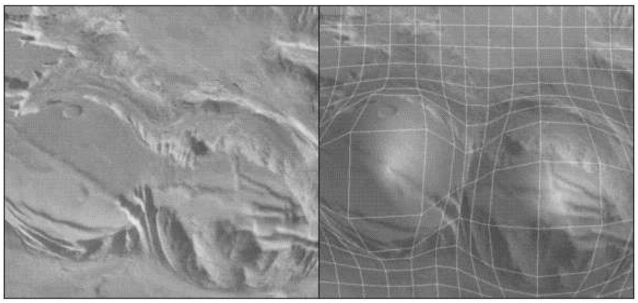

Figure 6: The surface of Mars: left same foci no cues, right with shading, fog and grid

FUTURE

This technique is an ideal browsing tool for multi-resolution images, allowing one to zoom in and out through sections of varying detail. Plates 3 and 4 reveal detail that was barely discernable. Currently the implementation takes advantage of OpenGL's MIPMapping and SGI Impact's hardware texture mapping facilities. The result is highly interactive allowing one to roll through images with a 'bubble lens'. However this approach has currently tied the possible image size to available texture memory. Our intention is to combine this technique with a multi-resolution storage approach [1]. Other applications include image annotation, multi-resolution painting and infinitely computable fractals.

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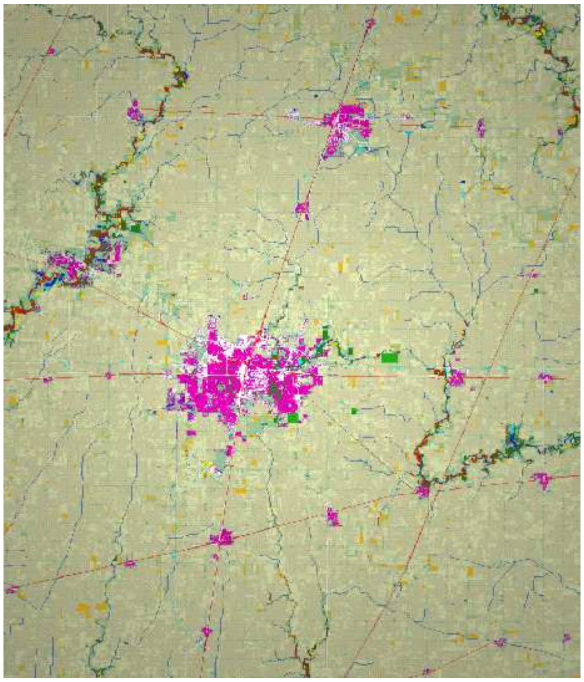

Figure 7: A single scale view of Champaign, Illinois

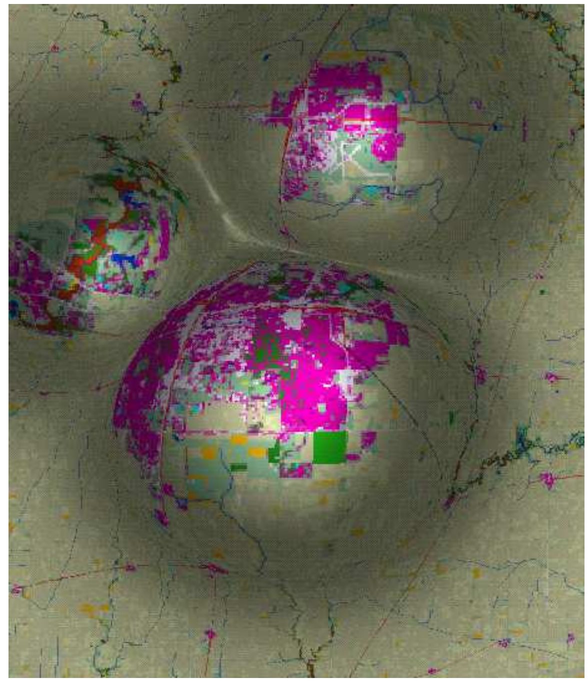

Figure 9: A multi-scale three foci view of Champaign

Figure 8: An aerial photo of New Orleans with SIGGRAPH logo inserted but not easily visible

Figure 10: One focus reveals the SIGGRAPH logo