City Lights: Contextual Views in Minimal Space

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ABSTRACT
City Lights are space-efficient fisheye techniques that provide contextual views along the borders of windows and subwindows that describe unseen objects in all directions. We present a family of techniques that use a range of graphical dimensions to depict varied information about unseen objects. City Lights can be used alone or in conjunction with scrollbars, 2D overview+detail, and interaction techniques such as zoomable user interfaces.

Keywords
Visual information workspaces, spatial hypertext, zoomable user interfaces, contextual views, overview+detail, fisheye views, focus+context, scrollbars

INTRODUCTION
Visual information workspaces, such as spatial hypertext systems [4,10,11] and zoomable user interfaces [2,3], share a significant navigation problem. Although these systems allow users to arrange objects flexibly in spaces and nested subspaces, they often provide few cues about objects that are currently out of view. As a result, users may be unaware of the existence or position of unseen objects, and/or they may be unable to navigate to them efficiently. So-called "desert fog" is an acute form of this problem in which no distinctive objects are visible [8].

One solution is to provide a separate overview window that shows the surrounding context for a detailed view [7]. However, separate overviews have several drawbacks. They divide the user's attention and require mental integration with the detailed view. Moreover, a single overview window cannot simultaneously show the surrounding context for a space and for its nested subspaces.

We have designed a family of techniques that provide contextual views in minimal space. We call our techniques "City Lights," extending the metaphor of information clusters as cities [5]. Just as the lights from a physical city are visible from a distance at night as a glow on the horizon, our techniques show information about unseen application objects via contextual views along the window borders.

Like scrollbars, City Lights are a compact representation that is integrated along the borders of a window, providing contextual awareness that easily supports multiple windows and subwindows. However, unlike scrollbars, City Lights are a directional, object-centric representation that is particularly well suited to visual information workspaces. City Lights are most similar to augmented scrollbars that show objects [6], but City Lights cues are typically larger than augmented scrollbar cues because City Lights depict a directional view of the space rather than the entire space.

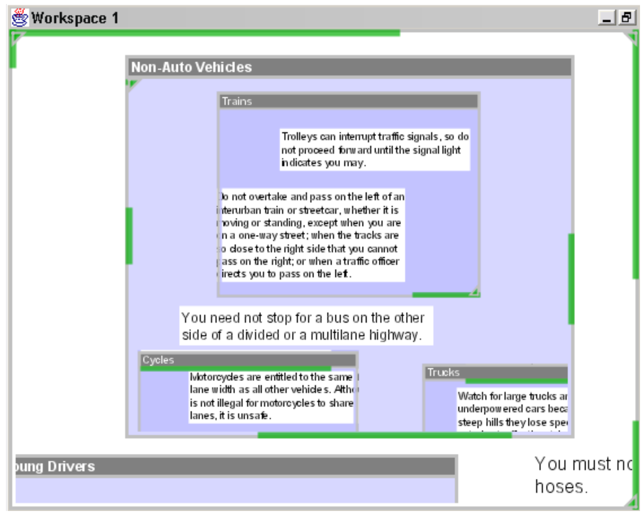

Figure 1: Thick lines on the borders of windows inform the user that this spatial hypertext of motor vehicle facts contains additional objects that are currently clipped. These City Lights cues show the height/width and orthographic direction of unseen objects. Triangles in the corners of the windows indicate that more unseen objects lie in adjacent unseen corner regions.

City Lights cues also support direct navigation. Clicking on a City Lights cue will move the view to the nearest object indicated by that cue. Thus City Lights cues act as a spatial form of hypertext link, providing directional awareness of more information and supporting targeted navigation to it.

We have implemented two forms of City Lights views. The first, shown in Figure 1, aids navigation in a spatial hypertext system called Niagara, which supports informal organization and classification of information. Niagara is based on Jazz, a Java ZUI toolkit with excellent support for nested infinite canvases and panning and zooming [3]. The second form, called *halos*, has been shown to improve user performance on map-based tasks on small mobile devices [1].

CITY LIGHTS

City Lights are discrete fisheye views placed along each border of a window to provide awareness of unseen objects in that direction. A family of visualizations can show varied information about unseen objects, including their existence, direction, distance, and relationship to seen objects. City Lights also support navigation to unseen objects.

Since City Lights must be compact to avoid disturbing window contents, choices must be made about what to show. City Lights techniques can show the following types of information about unseen objects: **awareness—**existence; **identification—**physical properties (size, color, shape, …), informational properties (type, state, …); **navigation—**positional information (direction, distance, …); and **interaction—**abstract information (history, degree of interest, …). Although we have explored all of these types, we emphasize information that supports navigation.

The remainder of our discussion of City Lights techniques follows a progression of graphical dimensions: points, lines, and 2D objects. Animation can be used to convey additional information about unseen objects.

City Light points show the direction of unseen objects by their placement on window borders. We have implemented both orthographic and radial projections. Orthographic projection is easy to calculate from the position of unseen objects, offering direct and intuitive navigation assistance. However, corner cues are required to show the presence of unseen objects that do not project orthographically onto the borders (see the corner triangles in Figure 1). Radial projection shows the direction of all objects in the populated space. However, radial projection is more complex during pan navigation, with points moving across adjacent borders.

City Lights points show distance information via gray/color variation. Since human perception is poor at decoding metric information from gray/color variation [9], we simplify distance to "near" and "far" and use two distinct colors. We also simplify the contextual view by depicting only unseen objects with a high degree of interest, such as those in the neighborhood of the focused view or those related to objects in the focused view. The shapes of points can also be used to describe unseen objects (see http://www.cc.gatech.edu/ii/webpda/).

In a second variation, City Lights lines (see Figure 1) convey information about the size of unseen objects. Orthographic projection produces a line length equal to the width or height of the corresponding object. Radial projection produces a line length that is a less obvious function of size and distance, which depicts the metric distance of the object if the size of the object is known. However, lines have the limitation that they blend together when unseen objects are clustered together. Combining City Lights points with City Lights lines shows the existence of individual objects in such clusters. Alternatively, City Lights lines can be juxtaposed or transparently overlaid to show multiple objects in a given direction, and can show multiple colors or textures to further distinguish unseen objects.

Finally, 2D objects can be used to provide space-efficient contextual views. A variation of City Lights called halos uses arcs based on circles drawn around the centers of unseen objects [1]. Arcs show both direction and distance to unseen objects, particularly for those nearby. Halos use minimal space by overlapping the focused view somewhat.

City Lights views can support other forms of interaction as well. Entering an interactive City Lights border can grow a 2D contextual view from the border to support either targeted navigation or additional information. Alternatively, when the user selects an object in the focused view, City Lights cues can use color variation to indicate which unseen objects are related to the selected object.

CONCLUSIONS

City Lights use points, lines, and/or 2D objects along the window and subwindow borders to provide contextual views of unseen objects in minimal space, with an emphasis on showing information such as direction and distance that will help the user navigate the focused view through the populated space. We have used City Lights as a part of the Niagara spatial hypertext system for classification tasks such as the motor vehicle facts shown in Figure 1. Our use experience is generally positive: points and lines do not intrude on the focused view or the rest of the display, and minimal training is required due to the intuitive metaphor. The 2D halo form has been shown to improve user performance on map-based tasks on small mobile devices [1]. Additional user studies will be needed to evaluate the relative merits of orthographic and radial projections.

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