Halo: Supporting Spatial Cognition on Small Screens

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ABSTRACT

As users pan and zoom, display content can disappear into off-screen space, particularly on small-screen devices. The clipping of locations, such as relevant places on a map, can make spatial cognition tasks harder. Halo is a visualization technique that supports spatial cognition by showing users the location of off-screen objects. Halo accomplishes this by surrounding off-screen objects with rings that are just large enough to reach into the border region of the display window. From the portion of the ring that is visible on-screen, users can infer the off-screen location of the object at the center of the ring. In our user study, participants completed all four types of map-based route planning tasks faster when using Halo then when using an arrow-based visualization technique.

Keywords

Halo, visualization, peripheral awareness, off-screen locations, hand-held devices, spatial cognition, maps.

INTRODUCTION

People use maps in a number of tasks, including finding the nearest relevant location, such as a gas station, or for hand-optimizing a route. Using a map, users can easily compare alternative locations, such as the selection of restaurants shown in Figure 1a (as indicated by the barn-shaped symbols). Users can see how far away a restaurant is from the user's current location, and whether it lies close to other locations the user considers visiting. When users are required to use a zoomed-in view, however, for example to follow driving directions (Figure 1b), relevant locations disappear into off-screen space, making the comparison task difficult[2]. Comparing alternatives then requires users to zoom in and out repeatedly—a time-consuming process that can hardly be accomplished on-the-fly. Especially on small-screen devices, such as car navigation systems or personal navigation devices, this can severely limit a user's capability with respect to spatial cognition tasks.

HALO

Halo [1] addresses this issue by virtually extending screen space through the visualization of the locations of off-screen objects. Figure 2a shows a map navigation system that is enhanced with Halo. The figure shows the same detail map as Figure 1b, but in addition the display also contains the location information contained in Figure 1a. The latter is encoded by overlaying the display window with translucent arcs, each indicating the location of one of the restaurants located off screen. Figure 2b shows how this works. Each arc is part of a circular ring that surrounds one of the off-screen locations. Although the arc is only a small fragment of the ring, its curvature contains all the information required for inferring the ring center, which is where the off-screen object is located. Although the display window shown in Figure 2a by itself contains no restaurant, the display informs users that there are five of them in the periphery and that the one located southwest is closest.

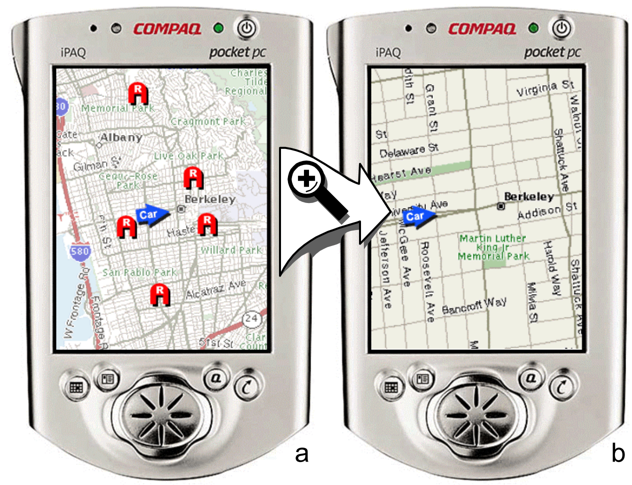

Figure 1: The problem: In order to make route decisions, users need to see the alternatives (a), but when drilling down to street information, relevant locations disappear into off-screen space (b).

Figure 3 shows how ring sizes are governed. As the map is panned, the restaurant moves from on-screen to off-screen. As the restaurant icon reaches the border region of the display window, a ring grows under the icon. As the restaurant moves further off-screen, ring radii are recomputed dynamically, so that the ring is always just big enough to reach into the border region of the display window while never occluding the display's central region.

Halo combines many of the advantages of other visualization techniques that have been used to display large documents on small screens. Unlike overview + detail

[1] The work reported in this paper was carried out during the author's affiliation with Xerox PARC, now PARC Inc.

[2] See also the concept of *desert fog* in zoomable interfaces [3].

visualizations [5] it offers a single view, that allows users to inspect detail information without losing context. Unlike fisheye views [2], Halo displays are not distorted, which is especially important for map-related tasks. Unlike techniques that use arrows to point to off-screen locations (such as City Lights [4]), Halo provides full information about the location of off-screen objects, not only their direction.

Figure 2: (a) Enhancing the map from Figure 1 with *Halo* shows where in off-screen space the five restaurants are located. (b) How it works: each off-screen location is located in the center of a ring that reaches into the display window.

Figure 3: As this location is panned out of the display window, a ring emerges from its center. The ring grows as the location is panned further away.

HALO IMPLEMENTS A STREETLAMP METAPHOR

The metaphor behind Halo is to represent off-screen locations as abstract "streetlamps" that cast their light onto the ground/map. This metaphor allowed us to derive four important properties for Halo. First, a streetlamp creates an aura, a large artifact which allows observers to infer the lamp's existence even if it is not in view. Second, the aura created on the map is round, allowing users to conclude the center location, even if only a small part of the ring is actually visible. Third, light overlays itself onto objects without occluding them; overlapping auras from multiple lamps aggregate nicely by adding up light intensities. Fourth, the fading of the aura with distance provides an additional visual cue about the distance of the streetlamp. An intense aura indicates a lamp located nearby; a weaker aura indicates a more distant lamp. The final design (Figure 2), has undergone three modifications. First, in order to make it easier to perceive the halo curvature, we replaced the smooth transition at aura edges with a sharp edge. Second, to minimize occlusion of window content and overlap between auras, we replaced the disks with rings. Third, we inverted the color scheme resulting in dark halos on a light background in order to better accommodate typical map material, which used a light background. The concept of fading arcs representing more distant locations was implemented by rendering the short arcs that represent nearby locations as nearly opaque and the longer arcs representing more distant location with increasing translucency.

USER STUDY

We conducted a user study comparing Halo with a visualization technique using arrows to point to off-screen locations [1]. Participants completed four tasks: locating off-screen locations, picking the closest off-screen location, arranging off-screen locations into the shortest possible traversal, and avoiding traffic jams. Subjects achieved significantly better task completion times in all four tasks when using the Halo interface (16-33% faster). For all four tasks, the majority of subjects expressed a preference for the Halo interface.

CONCLUSIONS

In this paper, we presented Halo, a visualization technique providing users with location awareness of off-screen objects. Halo provides a single non-distorted view of a document, overlaid with location information for the off-screen locations. Unlike arrow-based visualizations, Halo does not require explicit distance annotation; the distance information is encoded in the arcs themselves and directly incorporates the scale of the scene. Demo and video are at www.patrickbaudisch.com/projects/halo.

In future work, we plan to explore the application of Halo in the area of real-time tasks, such as simulations or highly interactive games where Halo arcs will be used to continuously update users about the location of moving objects in the user's periphery.

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