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Effect of control-to-display gain and movement direction of information spaces on the usability of navigation on small touch-screen interfaces using tap-n-drag

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ABSTRACT

Tap-n-drag is a popular navigation method for small touch-screen interfaces. When an information space is too large compared to the touch-screen size, navigating the information space using tap-n-drag requires too many drags, resulting in poor usability such as long navigation time or fatigue. In this study, the effect of control-to-display gain on the usability of tap-n-drag was experimentally investigated to determine whether increasing the control-to-display gain can resolve this problem. The effect of movement direction of the information space relative to the drag direction was also investigated (push background vs. push viewport). In experiments, increasing control-to-display gain seemed to increase the usability of tap-n-drag, but excessively large gain seemed to have the opposite effect on some measures such as task completion time, ease of use and overall preference; as a result these measures-vs.-GAIN curves were U-shaped or inverted-U-shaped. Overall, both task completion time and number of touches required to locate a target were lower when using push viewport than when using push background, except at GAIN = 1.

Relevance to industry: The results of this study can be used to enhance the usability of tap-n-drag and other navigation methods in small touch-screen devices when users navigate a large information space.

1. Introduction

1.1. Backgrounds

Facilitating completion of basic tasks in small touch-screen interfaces has been an important goal in Human-computer interface research. Navigation[1] is an important basic task on small screen devices because the size of the information space is frequently much larger than the screen size, so only a small portion of the entire information space is shown on the screen. For example, on a screen with a resolution of 320 × 240 pixel can present only about 1/11 and 1/17 of the total information when the sizes of the information space are 1024 × 768 pixel and 1280 × 1024 pixel, respectively (Gutwin and Fedak, 2004). In this case, navigating the entire information space is not an easy task. Zooming out the information space presents a larger portion of the information space and the navigation task requires less effort, but the size of the information such as text or image might become too small, thus causing problems in perceptibility or readability (Chung et al., 2011). Therefore, a variety of navigation methods on small touch-screen interfaces have been developed (Dearman et al., 2005; Jones et al., 2005; Burigat et al., 2007).

Two representative navigation methods used in commercialized mobile devices are 'flick' and 'tap-n-drag'. Navigating an information space using flick on a mobile device is analogous to throwing a sheet of paper on a flat surface while only a part of the paper is seen through a small window. Researchers have proposed that flick is an intuitive and natural method for shifting content within a viewing window (Geiβler, 1998; Reetz et al., 2006) and a compelling interaction method for navigating information spaces (Aliakseyeu et al., 2008). However, as flicking speed increases, visual feedback from the screen becomes a smooth or blurred transition from one part of the information space to another (Aliakseyeu et al., 2008), which makes the users may not perceive that their target has appeared on the screen and may miss its location in the information space. To reduce the effect of smoothing or blurring, the information space can be zoomed out when scrolling speeds are high (Igarashi and Hinckley, 2000).

'Tap-n-drag' is similar to 'flick' except that tap-n-drag 'drags' the information space while flicking 'throws' the information space. The user taps the touch-screen first, and keeps his or her finger tip

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[1] In this study, the term 'navigation' is defined as moving information spaces to make the desired targets appear in a screen. Similar terms are 'scrolling' (especially in one-dimensional movements of information spaces) or panning.

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