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MultiPoint: Comparing laser and manual pointing as remote input in large display interactions

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Abstract

We present MultiPoint, a set of perspective-based remote pointing techniques that allows users to perform bimanual and multi-finger remote manipulation of graphical objects on large displays. We conducted two empirical studies that compared remote pointing techniques performed using fingers and laser pointers, in single and multi-finger pointing interactions. We explored three types of manual selection gestures: squeeze, breach and trigger. The fastest and most preferred technique was the trigger gesture in the single point experiment and the unimanual breach gesture in the multi-finger pointing study. The laser pointer obtained mixed results: it is fast, but inaccurate in single point, and it obtained the lowest ranking and performance in the multipoint experiment. Our results suggest MultiPoint interaction techniques are superior in performance and accuracy to traditional laser pointers for interacting with graphical objects on a large display from a distance.

Keywords: Multi-touch; Remote interaction; Large display; Input device; Interaction technique

1. Introduction

Over the past few years, interactive large displays have gained traction as a vehicle for public and large-scale media—with applications in advertising, information visualization, and public collaboration (Ball and North, 2007; Brignull and Rogers, 2003). For example CityWall, a large multi-touch display installed at a central location in Helsinki, provided people with an engaging and highly interactive interface in an urban environment (Peltonen et al., 2008). The popularity of large interactive displays in these applications can, in large part, be attributed to their significantly increased screen real estate, which provides more pixels for collaboration, higher densities of information, or better visibility at a distance (Bi and Balakrishnan, 2009). Since large displays provide more physical space in front of the display, they also allow for multi-user applications that are not easily accommodated or communicated via standard desktop monitors (Vogel and Balakrishnan, 2005).

We believe this presents an opportunity to explore interaction techniques that capitalize on the inherent strength of large displays—greater screen real estate—when physical input devices are not readily available. While many innovative techniques have been proposed in the literature to deal with the difficulties in pointing at hard-to-reach parts of a large display, the majority focus on within-arms-reach interactions through touch or multi-touch, with the underlying assumption that the user stands sufficiently close to the screen to touch its surface (Brignull and Rogers, 2003; Myers et al., 2002; Peltonen et al., 2008). Alternatively, they require users to navigate a mouse cursor using some form of traditional pointing device (Baudisch et al., 2007).

1.1. Issues with walk-up-and-use

As Ringel et al. (2001) point out, the classic problem with multi-touch large display interactions is that users are

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required to walk up to the display to touch objects that are within arm's reach. Not only does this limit interaction with objects that are out of reach, walking results in a much lower Fitts' law performance than manual pointing (Oakley et al., 2008). Streitz et al. (1999) proposed the use of physics as a potential solution for this problem. However, when users step back from the display to view the contents of the entire screen, they can no longer interact with the graphics until they step forward to touch the screen. In the realm of seated cooperative work scenarios, we often observed a plenary turn taking mechanism, with only one user presenting in front of the screen. We believe this is, at least in part, due to the time required to get up and walk to the screen.

1.2. Issues with remote pointing

One solution is to use remote input techniques that allow users to point at large displays from a distance. One method explored is through the use of laser pointers (Myers et al., 2002). The laser pointer can be used from just about any position in front of the display. Unlike mice or styli, laser pointers do not require a surface to track cursor position. However, they present some limitations. First, one has to carry a laser pointer at all times. Second, multipoint techniques are mostly unavailable unless one uses a laser pointer in each hand.

An alternative method is direct freehand pointing, in which computer vision or another input method detects the location of fingers at a distance from the display (Vogel and Balakrishnan, 2005). As with laser pointers, one can perform ray casting using the vector of a pointing finger. However, when multipoint gestures are considered, it is no longer evident which fingers are participating in the gesture, or even that the fingers are directed at the display. As a solution for this, (Jota et al., 2010) explored an image-plane or perspective-based pointing technique (Pierce et al., 1997) that takes into account the line of sight of the user: fingers are directed at the display when they are within the boundary box perceived from the user's perspective. While their system allowed for bimanual input, it did not allow for multipoint gesturing between the hands, or within fingers of one hand.

1.3. Multipoint: multi-touch inspired gestures at a distance

MultiPoint enables users to remotely manipulate content on a large display. By performing multi-touch inspired in-air gestures, a user can perform manipulations similar to those afforded by a touch enabled interactive surface. MultiPoint employs image-plane or perspective-based pointing (Fig. 1) that follows a user's line of sight. Users can perform manipulations either bimanually, or simply with a single hand.

In this paper, we report on two experiments designed to investigate MultiPoint's potential. We explore the affordances associated with in-air interactions and compare them with laser pointer-based interactions. Our first experiment compares remote perspective-based pointing to laser pointing in a single point manipulation task (Fig. 2a). In addition, this experiment evaluates three selection techniques for remote content that have not been compared previously, including one introduced in the g-speak system (Oblong Industries). The second experiment measures the performance of remote multipoint input by comparing unimanual multipoint, bimanual multipoint, and dual laser pointing (Fig. 2b). We conclude with a discussion of the design space surrounding MultiPoint and provide conclusions regarding the suitability of each technique for systems that benefit from in-air interaction.

2. Related work

A large body of literature investigates solutions for walk-up-and-use and remote pointing. MultiPoint builds upon the following areas of previous research: (1) touch-based interaction; (2) device-based remote interaction techniques; (3) device-less remote interaction techniques.

2.1. Touch-based interaction

Touch-based multi-touch tabletop technologies like SmartSkin (Rekimoto, 2002) and DiamondTouch (Dietz and Leigh, 2001) could be used to interact with large upright wall displays. Barehands (Ringel et al., 2001) and Touchlight (Wilson, 2004) use computer vision to track bare, unmarked hands pressing against a vertical surface.

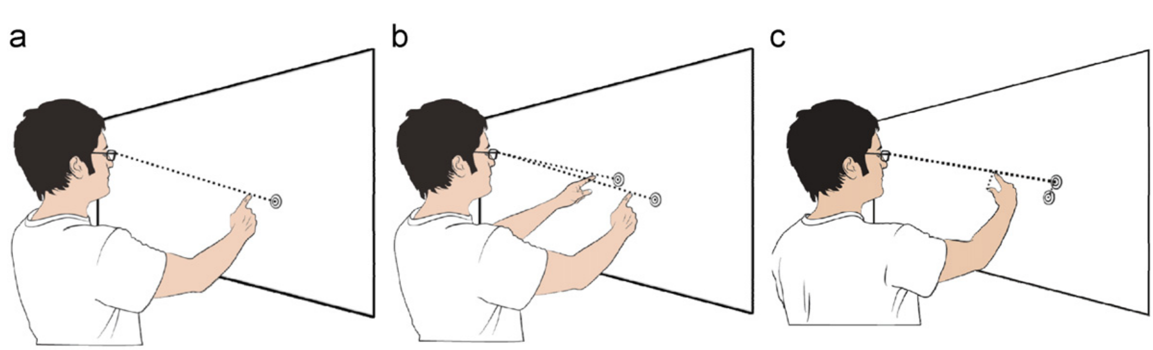

Fig. 1. Remote multipoint techniques. (a) Remote perspective-based single point , (b) Bimanual remote perspective-based multipoint and (c) Unimanual remote perspective-based multipoint