Demonstrating Proxemic Cursor Input for Touchless Displays

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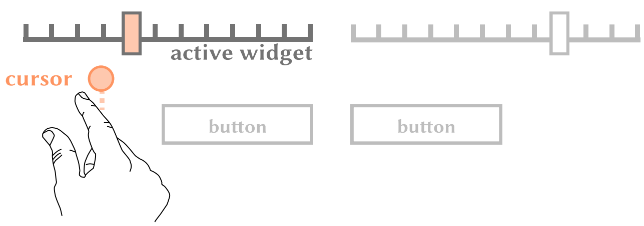
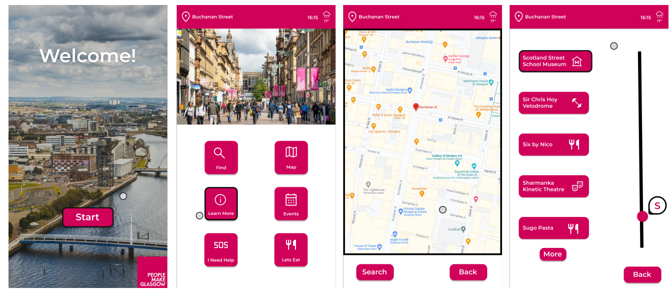


(a) Proxemic cursor concept



(b) Screenshot taken from sections of the touchless kiosk interface

Figure 1: Proxemic cursor widgets allow users to activate the nearest element to a gesture-controlled cursor in a touchless user interface, without directly targeting it.

ABSTRACT

Touchless gesture interfaces often use cursor-based interactions, where widgets are targeted by a movable cursor and activated with a mid-air gesture. Proxemic cursor interactions are a novel alternative that facilitate faster selection without the need for direct targeting. We present an interactive demonstration exhibit that uses proxemic cursor interactions for input to a touchless public display.

CCS CONCEPTS

• **Human-centered computing** → **Gestural input**.

KEYWORDS

Mid-Air Gestures, Proxemics, Touchless Interaction, Touchless Widgets

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1 INTRODUCTION

Touchless displays often use cursor-based interactions inspired by conventional pointer-based user interfaces. Users provide input by targeting user interface elements with the cursor, followed by a gestural action (e.g., pinching fingers together [12]) to activate or manipulate the targeted element, e.g., activating a button or moving a slider handle. This requires precise cursor control, which can be challenging due to instability, fatigue [10], and sensing issues [6].

Proxemic cursor interactions [13] are a novel alternative that reduce the precision needed to target interface elements: whilst the user is actively controlling the cursor (i.e., with in-air hand movements), the closest widget is automatically targeted. Our recent work investigated the usability of proxemic cursor interactions for touchless button activation and slider control. We found that proxemic cursor interactions led to faster task completion times and more relaxed targeting behaviours, since users did not need to precisely land the cursor on the desired target. They also allowed users to interact within a more comfortable range of motion, making it easier and more ergonomic to reach distant targets.

We present an interactive demonstration of proxemic cursor interactions for touchless public displays. Our system uses a pinch-activated proxemic cursor for button and slider input, and its user interface is informed by insights and recommendations from initial explorations of these interaction techniques [12, 13].

2 RELATED WORK

Touchless interaction has seen significant technical advances in recent years, with novel hardware and sensing methods helping establish touchless mid-air gestures as a core interaction paradigm for mixed reality devices and, to a lesser extent, public displays. Many touchless interfaces are inspired by traditional interaction paradigms (e.g., point-and-click, direct touch), in part due to trends of retrofitting touchless input to existing touchscreen devices.

Touchless interfaces therefore often use cursor-based designs, whereby the user controls a distal cursor by moving their hand in mid-air. There are some advantages of this, e.g., the direct mapping between cursor and hand position forces users to move their hands to a certain position in mid-air, helping them initiate interaction with the system [2, 3] and avoiding issues of gesturing in a position where sensing is poor [1, 5, 6, 11].

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Cursor-based interactions demand precision from the user, which can be challenging with mid-air gestures, especially when applied to legacy user interface designs with smaller targets. These interactions are also prone to usability issues like the Heisenberg Effect [14], where the cursor falls off the target due to the activation gesture, and fatigue associated with the extraneous hand movements necessary to reach distant widgets [10].

Alternative cursor designs have been developed to simplify the targeting process, e.g., Bubble Cursor expands to reach the nearest target to the cursor [4, 7], the 'fish eye lens' effect has been used to magnify targets close to the cursor [9], and 'summoning' methods bring targets to the cursor instead of the other way round [8]. In our own work, we investigated proxemic cursor interactions [13] that automatically target the nearest widget. We explored their use across a variety of user interface layouts for both button and slider input tasks, leading to new insights about how to use these effectively. In this paper, we put some of those insights into action to demonstrate a touchless UI with proxemic cursor widgets.

3 PROXEMIC CURSOR INTERACTIONS

3.1 Proxemic Targeting

Proxemic cursor control can be added to a touchless user interface by adapting the targeting mechanism to automatically select the nearest user interface element. Finding the closest widget is straightforward for simple controls like buttons: i.e., measure the minimum distance between cursor and button perimeter.

For more complex controls like sliders with static and dynamic components (i.e., slider bar and handle, respectively), determining proximity is not intuitive – should distance be measured to the slider itself, or to the slider handle? Based on our earlier work [12], we measure proximity using the handle position as this better met users' expectations of what it meant to 'acquire' the slider.

Once the closest widget is found it enters the 'in focus' state, like it would if directly targeted by an overlapping cursor. In our prototypes, this state is shown by highlighting the widget (as in Figure 1). Users can therefore always see which control is being targeted by the proxemic cursor.

3.2 Widget Activation

Targeted widgets can be activated as they would normally in a conventional touchless gesture interface, i.e., by performing an activation gesture. Many commercial touchless systems use "air push" gestures where the hand moves forward to 'push' the button, though this is prone to targeting slips [14]. Previous studies found finger-pinching gestures to be a more usable alternative [12], so we use these as our activation gesture.

3.3 User Interface Layout

The widgets are placed such that they are aligned vertically with more vertical space between them rather than horizontal. Although our full paper [13] suggests that the proxemic cursor is effective despite widget separation, users took advantage of increased vertical separations to target faster and with lesser need for precision. We also include a vertical slider bar, noting its advantages for proxemic targeting: Users tend to make smaller, more frequent adjustments with a vertical slider, resulting in more comfortable hand positions and reduced arm movement. This is without compromising task efficiency or completion time compared to a horizontally positioned slider.

4 DEMONSTRATION

Our demonstration consists of a touchless tourist information kiosk for the city of Glasgow, Scotland. Attendees can interact with the user interface using proxemic cursor interactions, tracked by a Leap Motion sensor. This gives a 'hands-on' experience of the interaction techniques presented in our full paper at ACM SUI '23 [13]. The user interface (Figure 1 (b)) itself exemplifies the lessons learned in that work about how to design effective and usable touchless user interfaces with proxemic cursor interactions. The kiosk interface contains both static widgets (buttons) and dynamic widgets (slider bars) showing different types of interactions and attendees can interact using two common activation gestures (Pinch and AirPush) along with the proxemic cursor both enabled and disabled. The system has been designed to emulate a realistic scenario in which a touchless proxemic cursor may be used.

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