Proxemics-Based Visual Concepts to Attract and Engage Public Display Users: Adaptive Content Motion and Adaptive User Shadow

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Abstract
Large interactive displays presenting useful content responding to users' actions are becoming ubiquitous in public places such as museums and campuses. Being an integral part of the surrounding environment, a major design challenge is to first attract passersby's attention and entice them to interact. One promising approach is to incorporate proxemics parameters to guide how the content are visually presented. In this paper we describe the design of a field experiment using user-display distances in determining how visual content was displayed, and its deployment at a university campus with frequent foot traffic. We also offer some selection criteria for reference when conducting a field experiment with public large interactive displays.

Author Keywords
Public Large Interactive Displays; Proxemics; Interface Design; Field Experiment

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

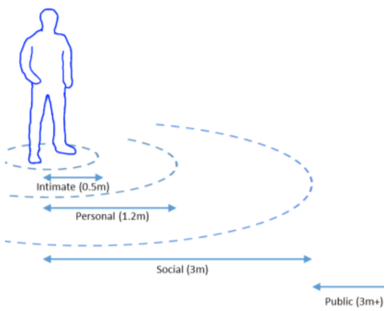

Figure 1. Depict of Hall's Proxemics Theory separating a person's behaviour into discrete proxemics zones of proximity.

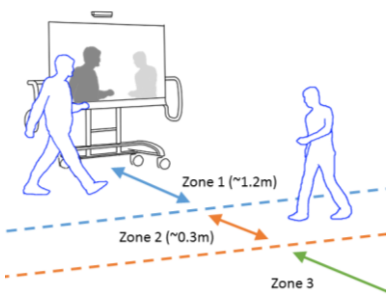

Figure 2. Zonal setup in the field experiment.

Introduction

Public Large Interactive Displays (PLIDs) have recently been adopted in many public places such as museums and campus, providing useful information (e.g. as part of an exhibit, campus map), and/or entertainment (e.g., mini-games). A commonly observed issue with such deployments, however, is that these displays often go unnoticed, and thus are underutilized [4, 6]. PLID designs must therefore first attract the attention of potential users and entice them to interact, or the display's usefulness will never be realized.

As more interactive techniques are available beyond multi-touch, PLIDs can now support various types of interactivity, for example, gestures [4], and proxemic interactions [1]. While allowing a greater interaction variety, these techniques might also help notifying passersby. In particular, the proxemic interactions system proposed by Ballendat et al. [1] provides proxemics parameters (e.g., distance, and orientation) that can be used to estimate the level of attention of a passerby, and adjust the visual content accordingly [7].

In previous work exploring the notion of combining proxemics parameters with visual content presentation to attract and entice users to a large display, we found that showing a user shadow, together with application content responding and adapting to user's proximity, showed promise in a laboratory setting [2]. Building on this result, we wished to further investigate the potential of these proxemics-based visual effects, both together and independently, in a more realistic public setting. This interactive demonstration showcases the proxemics-based visual concepts, namely Adaptive Content Motion and Adaptive User Shadow, that we developed and deployed as part of a field experiment to better understand their effectiveness in a public setting.

Proxemics Zones

Proxemic interactions are based on the *proxemics zones* by Hall [3] (see Figure 1), with which one can use the distance values to guide what level of details to be shown [7], or how visual stimuli are presented [2].

While other proxemics parameters (e.g., orientation, movement, identity) have been proposed [1] and could also be useful for such purpose [8], they often require more setup effort to be available (e.g., an elaborate tracking system with users wearing beacons [7, 8]). In balancing practicality and the information available, we opted to only use proximity (relatively simple to obtain with a depth sensor) as the proxemics parameter.

Combining proxemics zones and space available at the deployment location (discussed in the Deployment section), three zones were setup with boundaries of approximately 1.2m away, 1.5m away, and above 1.5m away from the display, as shown in Figure 2. As our research was primarily focused on the earliest stages of interaction (i.e., attracting attention and intriguing potential users to consider interacting with the display), we did not distinguish Intimate zone from Personal zone (see Figure 1), and combined them into a single zone (Zone 1 in Figure 2).

Visual Concepts

Extending our prior laboratory study [2], our field experiment focused on two main visual concepts, Adaptive Content Motion and Adaptive User Shadow.

In the Adaptive Content Motion concept, the speed of application content (images of our university campus) decreased in a stepwise manner as a passerby approached the PLID, so as to provide sufficient opportunities for interaction to occur, and the change

Figure 3. Illustration of the Adaptive User Shadow concept: Contrast of shadow increases when the passerby approaches the display, together with a natural scaling-up effect (proximity decreases from top to bottom).

more likely to be noticed. Speed for each content item was randomly chosen from between 11.3 to 22.5 cm/s as the starting speed, and was used when the passerby was at Zone 3 (furthest away from the PLID). When the passerby was at Zone 2, content would move at 60% of its starting speed; and at Zone 1 (closest to the display), it would move at 20% of its starting speed.

In the Adaptive User Shadow concept, a silhouette of the passerby was projected as if they were casting a shadow on the PLID. In contrast to a similar technique being used by Müller et al. [5] to increase the attraction power of a display and communicate its interactivity, we increased the contrast of the shadow continuously as a passerby approached the PLID. This visual contrast change was implemented by mapping the shadow's alpha value to 0 at 0.4m and 255 at 3.15m from the display. Furthermore, as a result of the perspective view of the camera used to render the silhouette, a passerby further away would project a smaller shadow, hence providing a natural scaling effect (Figure 3).

The field experiment also included a control condition, in which displayed content moved in a constant speed, and no user shadow was displayed.

Hardware and Software

A 164cm, multi-touch display (SMART[1] Kapp iQ 6065i) was used as the PLID, reporting up to four multi-touches as touch events to a connected Windows 8 PC (3.5GHz CPU, 16GB RAM, NVDIA Quadro K2200 display card) at a 1920x1080-pixels resolution. The surface was made using reinforced glass with metal enclosure, making it robust to frequent use and was mounted on a mobile stand of adjustable height (see Figure 4).

[1] http://smartkapp.com/en/products/kapp-iq

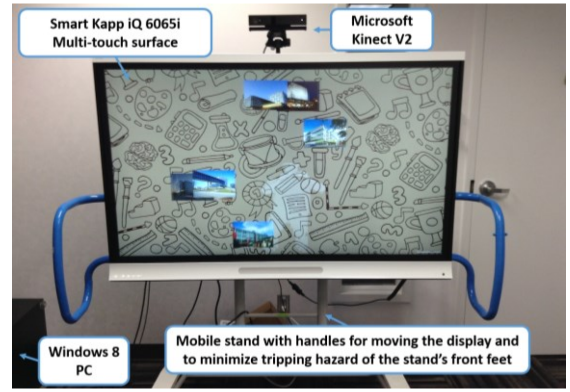

Figure 4. Hardware setup for the field experiment. The Kinect device was made visible by being installed on the top of the display. Content was photos of a university campus.

Visibly installed on top of the surface was a Microsoft Kinect V2, which measured the proximity of up to six passersby to a distance of 4.5m of millimetre precision. The proximity values were used by a custom software application developed using Unity 5[2] to determine the changes in speed for Adaptive Content Motion, and the changes in contrast for Adaptive User Shadow.

Summary of Deployment and Observations

Several criteria had to be met when determining a location for the field experiment, including 1) frequent foot traffic while possible for passersby to stay for a short period of time to interact, 2) a place for the researchers to observe the site unobtrusively, 3) power supply for the display to operate for several hours, and be accessible for transportation and storage of equipment over the duration of the experiment, and 4) legally and institutionally accessible to the researchers.

[2] http://unity3d.com/

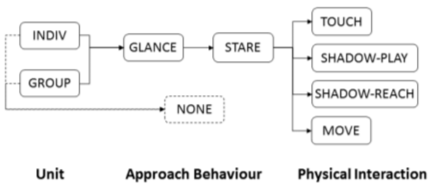

Figure 6. Annotation scheme of observable passersby behaviour used in the video analysis, indicating increasing levels of engagement from unknowing to attracted, and from attracted to engaged.

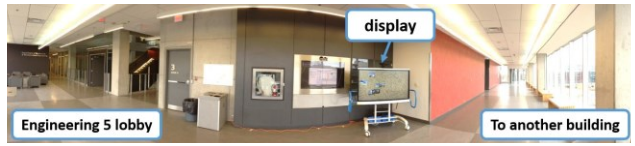

Figure 5. Deployment of the field experiment. The researchers (not shown in the figure) were stationed opposite to the display without any indication of a study in progress.

We decided to deploy the PLID in a lobby area of an Engineering building on our university campus that had an above-ground pedestrian pathway link between campus buildings (see Figure 5). Besides frequently traveled, this location satisfied all the above criteria.

The field experiment was conducted in an "in-the-wild" manner typical to studies of PLIDs [4–6], where interactions were captured using field notes, computer logs, and video recordings. Two researchers also observed from an unobtrusive location nearby, where students commonly sat at tables to study or complete assignments between classes. The collected video data was analyzed using an annotation scheme developed to identify recurring passerby behaviour. Log data were used to analyze system interaction, including user movement and dwelling in the space, and hand and body gestures made in front of the display. Overall, both visual concepts (independently and combined) were found to attract and entice interaction with the PLID, compared to the control condition. Both proxemics-based visual concepts increased users' length of stay (often called "holding power" in museum contexts) at the display over the control condition. The findings also showed that the visible Kinect device may have also attracted and enticed interaction from users, as many hand and body gestures in front of the display were observed, even in the absence of user shadows.

Conclusion

We present proxemics-based visual concept designs that adapt content's properties, namely, content speed and user shadow contrast and scale, based on users' proximity. Our deployment of these visual concepts found that they both effectively attracted passersby's attention in a public setting, and that they also showed some promise in enticing interaction. We hope to demonstrate their design and interactivity to conference participants and discuss potential strategies for refining their designs. We also hope to discuss extending the proxemic interactions approach to better facilitate user engagement, thereby leading to better utilization of public large interactive displays.

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