Using Gestural Interaction on Mobile Phones for Navigating 3D Information Spaces on Interactive Walls

Abstract
In this position paper we discuss a design space and early concept for interacting with mobile phones to navigate large 3D information spaces on interactive walls. The work is based on experiences from our previous research on different direct (multi-) touch interaction techniques for navigating the semantic space browser, a 3D information space allowing the exploration of folksonomies on multi-touch tables and walls. The results suggest touch interaction with constraints in order to support the orientation in 3D space. This paper discusses the transfer and extension of these results to a setting with mobile phone and interactive wall.

Keywords
Gestural interaction, mobile interaction, 3D user interfaces, multi-touch, interaction constraints, information visualization, folksonomies.

ACM Classification Keywords
H.5.2 Information interfaces and presentation (e.g., HCI): User Interfaces – Input devices and strategies
General Terms
Design, Human Factors

Introduction
3D information spaces offer great opportunities to explore and navigate large collections of data. However, good input techniques for 3D interaction are still challenging to design: if the interaction is done on a flat surface, we have to map 2D interactions to effects in 3D space; if we want to use 3D space and motion gestures for interaction, we have to find suitable and non-exhaustive interaction techniques. For both interaction scenarios, established standards do not exist yet. In this paper, we address the design space of combining mobile phone interaction with 3D information spaces on interactive walls. This scenario yields big potentials, as large sets of data can be visualized on a large-scale high-resolution screen and at the same time can be controlled remotely via the personal mobile phone. This concept has been discussed as part of multi-display-environments [11] and already applied in different setting, e.g. public displays [10], or with different technologies, e.g. projector phones [9].

Related Work
Integrating mobile phone interaction and large interactive walls allows the combination of a variety of different interaction techniques. Among these are full-body movements, hand gestures, touch gestures on the phone, mobile phone movement gestures, and touch gestures on the wall. Research in human-computer interaction has addressed a number of aspects relevant to this setting: e.g., Wobbrock et al. developed a multi-touch gesture set for interactive surfaces [13], Zigelbaum et al. designed g stale, a gestural interface tracking arm and hand movements [14], and Ruiz et al. worked on motion-gestures for mobile interaction [8]. Among the work that focuses on mobile phone interaction with walls, are, e.g., Boring et al.’s study on mobile interaction through video [2], Kray et al.’s gesture set for connecting mobile phones and public displays [7] and Dachselt et al.’s work on exchanging files via mobile phone gestures [5]. The specific challenge of this setting is to find suitable gestural interaction techniques for 3D information spaces. An overview on a number of interaction techniques for 3D manipulation and navigation can be found in [3]. Current examples of 2D and 3D interaction with stereoscopic displays can be found in [4] and [12]. In the following, we present our previous work on touch interaction with 3D user interfaces as well as a discussion of the design space for using mobile interaction with interactive walls.

Previous Work: The Semantic Space Browser and ElasticSteer
The Semantic Space Browser is a 3D information space, representing semantically clustered websites based on folksonomies¹. After selecting or entering a tag, the user gets an overview on clustered websites as shown in figure 1. When selecting a cluster, the user can choose between 3 different visualizations: wall, corridor, or carousel (see figures 2-4). Within these,

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¹ "Folksonomy is the result of personal free tagging of information and objects (anything with a URL) for one's own retrieval. The tagging is done in a social environment (usually shared and open to others). Folksonomy is created from the act of tagging by the person consuming the information." http://vanderwal.net/ folksonomy.html (last access January 24th, 2012).

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Figure 1. The Semantic Space Browser: Overview screen with clusters of websites for different tags (category “culture”).
the user can browse and explore the preview images of websites as well as select single pages.

While a first version of the software was controlled by mouse input, a second iteration used (multi-)touch "ElasticSteer" interaction, applying a rubber band metaphor by calculating speed and direction based on relative direction and distance to the starting point of a gesture \[1\]. We presented the Semantic Space Browser on an interactive wall and designed two touch interaction sets, one unconstrained set allowing to control all 6 degrees of freedom possible and one constrained set allowing to control translation in x and z axis within defined borders. The unconstrained input techniques used one finger to control camera yaw and depth, two fingers to control translation, and three fingers to control roll and pitch. The constrained input techniques only used one-finger touch interaction: moving along the x-axis controlled translation, moving along the y-axis controlled zoom. Additionally, each visualization was tailored according to its spatial metaphor (e.g., move around center of carousel, adjust camera). In line with earlier research on 2D interaction with 3D content (e.g., \[6\]), we found that constrained interaction was superior regarding a number of variables (task completion time, number of gestures used and view resets).

Using Mobile Phones for Navigating Large 3D Information Spaces on Interactive Walls

As a next step, we want to explore further gestural interaction techniques to interact remotely with the Semantic Space Browser on a wall (see figure 5). Using a mobile phone and adding a tracking system (which we assume could later be replaced by other available technology) allows us to consider different kinds of gestural input techniques, among which are full body and hand gestures, including position and orientation in the room, mobile phone motion gestures, and (multi-) touch gestural input on the mobile phone as well as (multi-) touch gestural input on the wall. The output design space contains: visual output on the large screen and visual output on the mobile phone, spatial sound in the room as well as sound on the mobile phone, and vibration feedback of the mobile phone.

Applying the path-constrained interaction techniques of the ElasticSteer interaction, we need to control the translation on the x-axis and the z-axis and provide a selection mechanism to select cluster and websites. One promising mobile device-and-wall interaction alternative for this concept could be an
ElasticSteerRemoteTouch approach: realizing x- and z-axis translation via touch on the mobile phone, providing haptic and visual interaction feedback on the phone and applying an adapted rubber band metaphor on the large screen that also considers the user’s distance to the wall as well as her angle of view. Further potential of this approach includes the combination of private and public displays, e.g., a single tap on the phone selects a webpage on the wall that can, once selected, be transferred to the mobile phone (e.g., via a touch gesture on the phone or via an arm gesture towards the body), to enable a personal collection of tagged items. A second variation of this approach could involve tilting the mobile phone for x-axis and z-axis translation (ElasticSteerRemoteTilt). We believe that a combination of these interaction techniques is promising for interacting remotely with large 3D information spaces. Future work will include testing and comparing the different techniques for settings with mobile phones and interactive walls.

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References


