Chapter 11

Investigating Serendipitous Smartphone Interaction with Public Displays

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ABSTRACT

Today’s smartphones provide the technical means to serve as interfaces for public displays in various ways. Even though recent research has identified several approaches for mobile-display interaction, inter-technique comparisons of respective methods are scarce. In this chapter, the authors present an experimental user study on four currently relevant mobile-display interaction techniques (‘Touchpad’, ‘Pointer’, ‘Mini Video’, and ‘Smart Lens’). The results indicate that mobile-display interactions based on a traditional touchpad metaphor are time-consuming but highly accurate in standard target acquisition tasks. The direct interaction techniques Mini Video and Smart Lens had comparably good completion times, and especially Mini Video appeared to be best suited for complex visual manipulation tasks like drawing. Smartphone-based pointing turned out to be generally inferior to the other alternatives. Finally, the authors introduce state-of-the-art browser-based remote controls as one promising way towards more serendipitous mobile interactions and outline future research directions.

INTRODUCTION

Digital signage technology such as public displays and projections are starting to become omnipresent in today’s urban surroundings. According to ABI Research (2011), the global market for such installations will reach almost $4.5 billion in 2016 indicating their increasing potential. However, typical public displays in the form of LCD flat screens are a passive medium and do not provide any interaction possibilities for an interested passerby. As our steady companions, smartphones have been identified as

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promising input devices for such remote systems. With their steadily expanding set of features such as
built-in sensors, high quality cameras, and increasing processing power, they enable several advanced
techniques to interact with large public displays.

Ballagas, Borchers, Rohs, & Sheridan (2006) investigated the available input design space and came
up with different dimensions for classifying existing mobile/display interaction techniques. E.g., they
suggest distinguishing between relative and absolute input commands as well as between continuous
and discrete techniques. A continuous technique may change an object position continually, using a
discrete technique the object position changes at the end of the task. Another commonly used dimen-
sion is the type of directness of a technique. A direct technique allows for the immediate selection of
a favored point on the screen through the mobile device, traditionally using a graphical approach. In
contrast, indirect approaches make use of a mediator, typically an on-screen mouse cursor which can be
controlled through the mobile device.

Following an early classification of interaction techniques (Foley, Wallace, & Chan, 1984) we extend
this smartphone/display interaction design space by the dimension of orientation-awareness taking into
account the increasing popularity of mobile gesture-based applications. In case of an orientation-aware
technique the position and/or orientation of the mobile device affects the interaction with the screen. In
contrast, orientation-agnostic approaches are not sensitive to device movement.

To learn more about upcoming orientation-aware interaction techniques and to evaluate their suitability
for spontaneous interaction with public displays in comparison to established techniques, we selected four
recent techniques for an in-depth comparative study. We decided to choose two novel orientation-aware
interaction techniques which are gaining increasing attention in industry and academia. These techniques
became feasible on smartphones only recently due to advances in mobile device technology. Respective
implementations have not been scientifically compared with existing more established techniques so far.
Thus their actual benefits in terms of performance and user acceptance have not been proven by now.

The first orientation-aware technique, the \textit{Pointer} (Figure 1, top right), is made possible due to gyro-
scopes integrated into mobile devices of the latest generation. Inspired by a laser pointer, this technique
enables the control of the mouse cursor by tilting and thus literally pointing towards the favored display
location with the mobile device. The second orientation-aware \textit{Smart Lens} technique (Figure 1, bottom
right) enables screen interaction over the live video of the smartphone. By targeting respective areas of
the remote screen through the built-in camera users may directly select a specific screen point by touch-
ing the mobile device display. Since this technique works on the device’s live video, it inherently offers
a zoom feature by reaching out and moving the device closer to the display and vice versa.

As more established techniques for our comparison we chose two orientation-agnostic interaction
approaches with implementations already publicly available in mobile application stores. These two
techniques represent respective counterparts to the abovementioned novel ones according to the dimen-
sion of directness. The indirect \textit{Touchpad} technique (Figure 1, top left) makes use of a common interac-
tion style and exploits the touchscreen of the mobile device in analogy to the touchpad of a notebook
computer: strokes on the touchscreen are reflected by respective mouse cursor movements on the remote
screen. Finally, \textit{Mini Video} (Figure 1, bottom left) represents an orientation-agnostic direct interaction
technique showing a cloned miniature view of the large display on the mobile device. Touches on the
smartphone display are directly mapped to corresponding large display coordinates.

Table 1 shows the four distinct interaction techniques we explore in detail according to the traditional
dimension of directness and the novel dimension of orientation-awareness.