Chapter VI
Understanding One-Handed Use of Mobile Devices

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ABSTRACT

Mobile phones are poised to be the world’s most pervasive technology, already outnumbering land lines, personal computers, and even people in some counties. Unfortunately, solutions to address the usability challenges of using devices on the move have not progressed as quickly as the technology or user distribution. Our work specifically considers situations in which a mobile user may have only one hand available to operate a device. To both motivate and offer recommendations for one-handed mobile design, we have conducted three foundational studies: a field study to capture how users currently operate devices; a survey to record user preference for the number of hands used for a variety of mobile tasks, and an empirical evaluation to understand how device size, interaction location, and movement direction influence thumb agility. In this chapter we describe these studies, their results, and implications for mobile device design.
INTRODUCTION

The handheld market is growing at a tremendous rate; the technology is advancing rapidly and experts project that over one billion mobile phones will be sold in this year (2007) alone (Milanesi et al., 2007). To meet customer demand for portability and style, device manufacturers continually introduce smaller, sleeker profiles to the market. Yet advances in battery power, processing speed, and memory allow these devices to come equipped with increasing numbers of functions, features, and applications. Unfortunately these divergent trends are at direct odds with usability: richer content accessed through shrinking input and output channels simply makes devices harder to use. The unique requirements for mobile computing only compound the problem, since mobile use scenarios can involve unstable environments, eyes-free interaction, competition for users’ attention, and varying hand availability (Pascoe, Ryan, & Mores, 2000). While each of these constraints requires attention in design, we are currently interested in issues of usability when a user only has one hand available to operate a mobile device.

Devices that accommodate single-handed interaction can offer a significant benefit to users by freeing a hand for the host of physical and mental demands common to mobile activities. But there is little evidence that current devices are designed with this goal in mind. Small, light mobile phones that are easy to control with one hand are unfriendly to thumbs due to small buttons and crowded keypads. Larger devices, such as personal digital assistants (PDAs) are not only harder to manage with a single hand, they tend to feature more (rather than larger) buttons, as well as stylus-based touchscreens whose rich interface designs emphasize rich information content, but often offer targets too small, and/or too distant, for effective thumb interaction.

While it may seem obvious which features inhibit single-handed use, there has been relatively little systematic study of enabling technologies and interaction techniques. Most commercial and research efforts in one-handed device interaction have focused primarily on either a specific technology or task. For example, accelerometers have been explored to support tilt as a general input channel for handheld devices (Dong, Watters, & Duffy, 2005; Hinckley, Pierce, Sinclair et al., 2000; Rekimoto, 1996), while media control (Apple, 2006; Pirhonen, Brewster, & Holguin, 2002) and text entry (Wigdor & Balakrishnan, 2003) have been popular tasks to consider for one-handed device operation. But in the varied landscape of mobile devices and applications, one-handed design solutions must ultimately extend to a wide range of forms and functions. We began our investigation of this problem by looking at the fundamental human factors involved in operating a device with a single hand.

In this chapter, we report on three studies conducted to understand different aspects of one-handed mobile design requirements. We first ran a field study to capture the extent to which single-handed use is currently showing up “in the wild.” Second, we polled users directly to record personal accounts of current and preferred device usage patterns. The results from these studies help motivate one-handed interface research, and offer insight into the devices and tasks for which one-handed techniques would be most welcomed. Finally, we performed an empirical evaluation of thumb tap speed to understand how device size, target location, and movement direction influence performance. From these results we suggest hardware-independent design guidelines for the placement of interaction objects. Together our findings offer foundational knowledge in user behavior, preference, and motor movement for future research in single-handed mobile design.

BACKGROUND

The physical and attention demands of mobile device use were reported early on for fieldworkers (Kristoffersen & Ljungberg, 1999; Pascoe et al., 2000), from which design recommendations for minimal-attention and one-handed touchscreen interface designs emerged (Pascoe et al., 2000). Though well suited to the directed tasks of fieldwork, the guidelines do not generalize to the varied