Chapter XIX
Advanced Hands and Eyes Interaction

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ABSTRACT

This chapter gives an overview of the broad range of interaction techniques for use in ubiquitous computing. It gives a short introduction to the fundamentals of human-computer interaction and the traditional user interfaces, surveys multi-scale output devices, gives a general idea of hands and eyes input, specializes them by merging the virtual and real world, and introduces attention and affection for enhancing the interaction with computers and especially with disappearing computers. The human-computer interaction techniques surveyed here help support Weiser's idea of ubiquitous computing (1991) and calm technology (Weiser & Brown, 1996) and result in more natural interaction techniques than in use of purely graphical user interfaces. This chapter will thus first introduce the basic principles in human-computer interaction from a cognitive perspective, but aimed at computer scientists. The human-computer interaction cycle brings us to a discussion of input and output devices and their characteristics being used within this cycle. The interrelation of the physical and virtual world as we see it in ubiquitous computing has its predecessors in the domain of virtual and augmented realities where specific hands and eyes interaction techniques and technologies have been developed. The next step will be attentive and affective user interfaces and the use of tangible objects being manipulated directly without using dedicated I/O devices.

INTRODUCTION AND BASIC PRINCIPLES

One of the major principles in the interaction of a human with the real world is the combined use of the human vision system with our motor system (this is true for most animals as well). While visually sensing our environment, we are able to control our movements and our haptic action, such as touching and grasping things, thus interacting with the environment using our hands. The principles of hand-eye coordination have been studied intensively by human biologists and by psychologists (Anderson, 2004).

In the area of human-computer interaction, hand and eye coordination dominates most of our current use of contemporary computers. We mainly utilize a visual display where interaction elements are visualized, and we operate on these user interfaces with a keyboard to enter text and other symbols. We typically use a mouse as a pointing device allowing us to place the interaction focus onto one specific position on the display and to click on, and thus activate, the interaction element at this position.

In order to analyze existing user interfaces, to construct more efficient ones, and also to investigate human performance in senso-motoric systems Card, Moran, and Newell (1983) describe a simplified model of the human as an information processor (Figure 1). This model served the three authors as the foundation of their GOMS model to predict human performance (GOMS = goals, operators, methods, selection rules).

Concerning hands and eyes interaction using a computer, the model works as follows: At first, we see a specific visual output on a display using our eyes (the ears are left out intentionally in this chapter). Our perceptual processor senses the respective input as physical light and color stimuli. Inside our cognitive system we offer as a part of our short-term memory a store for visual impressions (besides one for auditive input). The content in the short-term visual memory is interpreted by the cognitive processor to decide on whether the impression should be stored for longer (for potential later use) and to decide how to react to the impression with our motor system. If we, for instance, see a car approaching us, the cognitive processor would decide to tell the mo-

Figure 1. Card, Moran and Newell's model human processor (Card, Moran, & Newell, 1983)