Chapter IX
Temporal and Spatial Aspects of Pointing Gestures

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ABSTRACT
The detailed and profound understanding of the temporal and spatial organisation of human pointing actions is key to enable developers to build applications that successfully incorporate multimodal human computer interaction. Rather than discussing an ideal detection method for manual pointing we will discuss crucial aspects of pointing actions in time and space to develop the right solution for a particular application. One core element of pointing in the temporal domain is the so called dwell-time, the time span that people remain nearly motionless during pointing at objects to express their intention. We also discuss important findings about the spatial characteristics of the target representation for the pointing gesture. The findings foster better understanding of the role of pointing gestures in combination with other modalities and inform developer with substantial knowledge about the temporal-spatial organisation of the pointing gesture.

INTRODUCTION
Some of humans’ intentions can be anticipated and identified in real life situations from their actions and the context in which they are performed. An important and frequent gesture is the manual pointing action that allows humans to refer naturally and intuitively to distant objects in the environment. In a more general definition, pointing by a human at an object is understood as “how one organism manipulates the visual attention of another to some distant entity” (Leavens, 2004).
With respect to gesture research in the context of language and semiotic, the pointing gesture or deictic gesture is named as one of four types of gestures that accompany utterances (co-verbal) (McNeill, 1992). Unlike iconic and metaphoric gestures, the deictic gesture does not convey an image of an object but rather establishes a link between what is uttered and the current spatial context. Manual or free-hand pointing can be considered as a “referential act” and therefore, represents a basic means to communicate with others aside speech. This embodiment of communication makes use of implicit references, whereby movements of the body bind objects in the world to cognitive programs (Ballard et al., 1997). A single human can easily coordinate and execute actions and it requires little effort for another human to predict the actions and recognize the intention merely by watching the movements. Therefore, pointing represents a basic and ubiquitous device to communicate with others (Kita, 2003) and is often used in communicative situation to establish a common ground over the course of the conversation (Clark & Wilkes-Gibbs, 1986). Consequently, this has also implications for ways humans interact with computers. It is important to understand what “behavior” or what kind of “reaction” has to be exhibited by the computer in order to meet the expectation of the user, especially when a computer should operate like a dialogue partner or accept more intuitive input signals from humans. It is also important to understand how humans perform manual pointing to select the best method to detect the act of pointing and the referenced object in a particular use context or application. This chapter provides an overview about the temporal and spatial aspects of human pointing in order to implement accurate and effective pointing gesture recognition and to successfully develop in multimodal applications.

**BACKGROUND: POINTING IN THE CONTEXT OF MULTIMODAL HCI**

In the typical situation of human computer interaction the user moves a physical device such as a mouse so that a screen cursor is placed over an element of the two-dimensional graphical user interface. With respect to the prior definition of pointing, the user’s referential act raises the “attention” of the computer as a dialogue partner (Maybury & Wahlster, 1998; Schomaker et al., 1995) for the object located under the screen cursor. After placing the cursor on the target, the user usually clicks on a mouse button and therefore explicitly signalling the intention to execute the function or the command that is associated with that interface element. This overall interaction is known as “point and click”. Furthermore, an interaction technique referred to as hovering is used in situations in which a mouse-click is not applicable or available for the user, e.g., during “drag and drop” or in pen-based interfaces. Nevertheless, to select a function, the user must hold the pointing device motionless for a certain period of time, to trigger a hover event by temporal discrimination. This provides information about the object in the focus of the attention. The “act” of hovering replaces the explicit click and allows for the selection of the target object.

In non-WIMP (Windows Icons Menus Pointing devices) based computer systems the free-hand gesture as a mode of input is still a relatively new phenomenon in the fields of multimodal user interface and human-computer interaction (HCI) research. Despite insightful studies into their uses in command and control interfaces, e.g., (Schapira & Sharma, 2001), there is a need for improved understanding of how they can best be applied to practical interfaces. The explicit act of clicking becomes substituted in non-WIMP interfaces either by an event of another modality or by an event created by temporal and spatial segmentation. On the one hand, tool-based interfaces, e.g., using pen-based gestures are inherently robust,
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