Chapter 2.37
Kinetic User Interfaces:
Physical Embodied Interaction with Mobile Ubiquitous Computing Systems

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ABSTRACT

This chapter presents a conceptual framework for an emerging type of user interfaces for mobile ubiquitous computing systems, and focuses in particular on the interaction through motion of people and objects in physical space. We introduce the notion of Kinetic User Interface as a unifying framework and a middleware for the design of pervasive interfaces, in which motion is considered as the primary input modality.

INTRODUCTION

Internet and mobile computing technology is changing the way users access information and interact with computers and media. *Personal Computing* in its original form is fading and shifting towards the ubiquitous (or pervasive) computing paradigm (Want et al., 2002). Ubiquitous Computing systems are made up of several interconnected heterogeneous computational devices with different degrees of mobility and computing power. All of these devices and appliances are embedded in everyday objects, scattered in space, capable of sensing the environment and of communicating with each other, and carried or exchanged by people. Therefore, we are facing a new ecology of computing systems that poses new issues in their integration and usability. Human-computer interfaces that were designed for desktop personal computers must be re-conceived for this new scenario. Due to the different capabilities

of mobile and embedded devices, the pervasive computing infrastructure, and the nature of their expected usage, it is apparent that new types of user interfaces are needed in order to unleash the usability of new generation distributed computing applications (see (Rukzio, 2006) for a classification of mobile devices interfaces). Additionally, the concept of user interface itself seems to be no longer adequate to cope with ubiquitous computing systems. Rather, it is the concept of interaction and user experience that will take over (Beaudouin-Lafon, 2004).

Ubiquitous Computing

Ubiquitous Computing (henceforth Ubicomp) is an emerging research sub-area of Distributed Systems whose main focus is studying how heterogeneous, networked computing devices can be embedded in objects of daily use in order to enable new applicative scenarios and user experiences. Mark Weiser (1991; 1993; 1994) introduced the term Ubiquitous Computing in the '90s as a new way to understand computer technology and to lay the foundations of an expected and necessary computing paradigm revolution. Weiser's vision has been adopted and interpreted by a great number of researchers, among whom we consider relevant for our goals the works of (Abowd & Mynatt, 2000; Abowd et al., 2002; Banavar & Bernstein, 2004; Bellotti et al., 2002; Greenfield, 2006; Norman, 1999; Want et al., 2002). We summarize the Ubicomp vision in four fundamental points that motivate our effort of providing a new conceptual framework for Ubicomp user interfaces:

1. Today's computer (e.g., the personal computer) will disappear, and the computing power will fade inside the network infrastructure, as it is already the case to some extent with existing web-services.
2. Computing will be extremely distributed and heterogeneous. This will result from the interconnection of several computing devices, each specialized in specific tasks and scattered in the physical environment (ranging from embedded devices to high-performance servers).
3. Computer interfaces will no longer capture the full attention of users. Rather, computer applications will run in "background" most of the time, accomplishing "routinized" operations, and they will try to gain user's attention only when strictly required.
4. Computer interfaces will be unobtrusive and based on new emerging interaction models obtained by direct interaction with physical objects and with the whole environment.

Ubiquitous Computing is often equated to (or better, confused with) nomadic computing (Kleinrock, 1997). Nomadic computing is a form of computing environment that offers its users access to data or information from any device and network while they are in state of motion. In nomadic computing, the use of portable devices (such as laptops and handheld computers) in conjunction with mobile communications technologies enables users to access the Internet and data on their home or work computers from anywhere in the world. Mobile connectivity certainly does play an important role in Ubicomp, but it is not the only one. We consider of central importance the *user's mobility* intended as the user's *ability of moving objects and themselves in the physical space.* In fact, in using Ubicomp systems, users are no longer forced to sit in front of a desktop computer and to operate it with mice, keyboards and local input/output devices. Users will interact through actions performed on everyday objects that surround them. As pointed again by Weiser[1]:

[ubiquitous computing] *is different from PDAs, dynabooks, or information at your fingertips. It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere.*