Wearable and Mobile Devices

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INTRODUCTION

Information and Communication Technologies, known as ICT, have undergone dramatic changes in the last 25 years. The 1980s was the decade of the Personal Computer (PC), which brought computing into the home and, in an educational setting, into the classroom. The 1990s gave us the World Wide Web (the Web), building on the infrastructure of the Internet, which has revolutionized the availability and delivery of information. In the midst of this information revolution, we are now confronted with a third wave of novel technologies (i.e., mobile and wearable computing), where computing devices already are becoming small enough so that we can carry them around at all times, and, in addition, they have the ability to interact with devices embedded in the environment.

The development of wearable technology is perhaps a logical product of the convergence between the miniaturization of microchips (nanotechnology) and an increasing interest in pervasive computing, where mobility is the main objective. The miniaturization of computers is largely due to the decreasing size of semiconductors and switches; molecular manufacturing will allow for "not only molecular-scale switches but also nanoscale motors, pumps, pipes, machinery that could mimic skin" (Page, 2003, p. 2). This shift in the size of computers has obvious implications for the human-computer interaction introducing the next generation of interfaces. Neil Gershenfeld, the director of the Media Lab's Physics and Media Group, argues, "The world is becoming the interface. Computers as distinguishable devices will disappear as the objects themselves become the means we use to interact with both the physical and the virtual worlds" (Page, 2003, p. 3). Ultimately, this will lead to a move away from desktop user interfaces and toward mobile interfaces and pervasive computing.

BACKGROUND

Mobile computing supports the paradigm of any-time-anywhere access (Perry et al., 2001), meaning that users have continuous access to computing and Web resources at all times and where ever they may be. Used in a wide range of contexts, mobile computing allows:

1. The extension of mobile communications and data access beyond a desktop and static location.
2. Access to electronic resources in situations when a desktop/laptop is not available.
3. Communication with a community of users beyond the spatio/temporal boundaries of the work or home location.
4. The ability to do field work; for example, data collection, experience recording, and notetaking.
5. Location sensing facilities and access to administrative information.

Mobile devices have several limitations due to their small size (form factor) that need to be considered when developing applications:

1. **Small Screen Size:** This can be very limited, for example, on mobile phones. Solutions to this problem necessitate innovative human-computer interaction design.
2. **Limited Performance:** In terms of processor capability, available memory, storage space, and battery life. Such performance issues are

continuously being improved, but to counter this, users' expectations also are growing.

3. **Slow Connectivity:** Relatively slow at the moment for anywhere Internet connectivity; 3G technologies promise to improve the situation. Wireless LAN connectivity, such as 802.11, provides simple and reliable performance for localized communication.

Mobile devices generally support multimodal interfaces, which ease usability within the anytime-anywhere paradigm of computing. Such support should include:

*   Pen input and handwriting recognition software.
*   Voice input and speech recognition software.
*   Touch screen, supporting color, graphics, and audio where necessary.

In order to take advantage of the promise of mobile computing devices, they need to have operating systems support such as:

*   A version of Microsoft Windows for mobile devices.
*   Linux for mobile devices.
*   Palm for PDAs.
*   Symbian for mobile phones.

In addition, mobile devices need to support applications-development technologies such as:

*   Wireless Application Protocol (WAP), where in the current version content is developed in XHTML, which extends HTML and enforces strict adherence to XML (eXtensible Markup Language).
*   J2ME (Sun Java 2 Micro Edition), which is a general platform for programming embedded devices.
*   .NET framework, which includes Microsoft's C# language as an alternative to Java.
*   NTT DoComo's i-mode, which currently covers almost all of Japan with well over 30 million subscribers. Phones that support i-mode have access to several services such as e-mail, banking, news, train schedules, and maps.

Standard software tools also should be available on mobile devices to support, among other applications:

*   E-mail.
*   Web browsing and other Web services.
*   Document and data handling, including compression software.
*   Synchronization of data with other devices.
*   Security and authentication.
*   Personalization and collaboration agents.
*   eLearning content management and delivery, which is normally delivered on mobile devices via its Web services capability.

Apart from the last two, these tools are widely available, although the different platforms are not always compatible. This is not a major problem, since communication occurs through standard Web and e-mail protocols. Current personalization and collaboration tools are based mainly on static profiling, while what is needed is a more dynamic and adaptive approach. There are still outstanding issues regarding content management and delivery of eLearning materials, since these technologies, which we assume will be XML-centric, are still evolving.

HCI AND MOBILE AND WEARABLE DEVICES

This article will highlight some of the central HCI issues regarding the design, development, and use of mobile and wearable devices. Our review pertains to devices such as mobile phones, personal digital assistants (PDAs), and wearable devices, and less to mobile devices such as laptops and tablet PCs that generally are larger in size.

Several main issues regarding the HCI issues of using mobile and wearable devices have been posited in the literature, including contextual concerns (Lumsden & Brewster, 2003; Sun, 2003), limitations of the interface (Brewster, 2002), and their convergence with other technologies and systems. These devices reflect the range of different contexts that mobile and wearable technology can be used for interfacing with data sets, interactive content, and enhanced visual display that augment activities and exploration within physical environments.

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