Distributed and Disappearing User Interfaces in Ubiquitous Computing

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INTRODUCTION

New concepts for human-computer interaction have to be developed when envisioning ubiquitous computing scenarios [7]. Instead of a single screen-based user interface (UI), humans will interact with a number of devices that are distributed and interconnected. These computers range from highly personal and mobile appliances to systems that are integrated in everyday environments and are more or less invisible. When all the potential components are considered together, the design space for the UI becomes much larger than with conventional personal computers. In the process of designing UIs, decisions on the distribution of the input as well as the output through both space and time are needed. This also raises questions on how to deal with alternative, multiple input options, redundant output opportunities, and the fact that many of these UIs cannot expect to have people's attention for a long time.

In addition to the distribution of the user interfaces in ubiquitous computing scenarios, the challenge of reducing the need for *explicit* human-computer interaction (HCI) becomes central. If the computing system has an awareness of the situation, the environment and the aims of the user, the system is able to reduce the need for explicit HCI [1, 5]. The ultimate goal of this approach is to let explicit interfaces virtually disappear into the environment, being noticed only when needed. Basic technologies for disappearing interfaces are sensing technologies (environmental conditions, users' location and co-location with others, physiological and emotional state of the user, goals, schedules, *etc*.) to capture the situational context [6]. One also need ways of combining a multitude of sometimes contradictory inputs to make sense at a higher level, and ways of adopting a system's output to be appropriate (from the users' point of view) to whatever situation might arise.

In line with these issues, the European Union (EU) has recently launched the Disappearing Computer initiative [8], focusing on how new functionality and new use can emerge from interacting computationally-enabled every-day objects, while stressing people's experiences with such environments. We propose a workshop at CHI 2001 to provide an international forum to discuss this approach.

Novel research issues

Current computer technology interaction is mainly explicit - the user tells the computer at a certain level of abstraction (e.g., by command-line, direct manipulation using a GUI, gesture, or speech input) what she expects the computer to do. In contrast, *implicit human-computer interaction* allows the computer to interpret the user's behavior and the surrounding situation and use this information as input [5].

When several co-located people interact with (or become affected by) an artifact simultaneously, perhaps with conflicting goals, the very notion of '*a* user' become problematic in many situations. How can we capture and model such issues, and how do we resolve conflicts? To what extent is a person a user of a system if all interaction with it is implicit, and the person is unaware of it? Until now, most research on 'smart environments' and the like has neglected such issues. As people will expect a coherent experience, we will have to consider interacting with complex environments, rather than just interacting with relatively isolated computer systems.

Many 'disappearing' UIs will be almost invisible in the literal sense, whereas others will be very visible, but not at all perceived as computers by the users [3]. Unlike traditional computers, many of these artifacts will not be used to perform specific (*e.g.*, work-related) tasks, in a tool-like sense, and therefore people's expectations and requirements on them will differ greatly. Aesthetical considerations, *e.g.*, whether some artifact suits one's personal style of expression, will often dominate the pure functional aspect to a user. We are already witnessing this transition with mobile phones.

Novel computational artifacts based on these technologies may become 'invisible', or reside in the background, in several different ways:

Truly invisible - when the actual computer and its interface is almost totally integrated with an environment that is familiar to the user. The user interaction model is implicit and perhaps even unnoticeable to the user. Such a system truly resides in the background of the user's attention at all times.

Transparent - here the 'invisible' UI is not invisible in the literal sense. Rather, it is transparent in the same sense as a very familiar tool is transparent to its user, to the point where it almost acts as an extension of one's body. Every-

day examples include the chef's knife, the carpenter's hammer, and the musical instrument of a professional artist. When using such tools, one does not explicitly think about the UI. Rather, the user's full attention is on what to accomplish by means of the artifact.

Subordinated - the functional aspect of the artifact is subordinated by some other, often aesthetical or personal, aspect. Consider for instance the clothes people wear. Of course clothes have to be functional in the sense that they protect the body and keep it warm, but there are typically other reasons why someone wears a particular type or brand of clothes. Applied to computational artifacts, the functional aspects are simply taken for granted and not given much thought from the user (*e.g.,* mobile phones).

As human-computer interaction design turns into environment design, we need to consider not only efficient tools for high-paced work, but also to consciously design technology that encourages moments of reflection and mental rest [2]. When designing the computational artifacts of tomorrow, we will have to, implicitly or explicitly, consider how people will relate to, perceive and experience them everywhere, anytime.

THEMES AND TOPICS

In the workshop we will explore how distributed and disappearing user interfaces can be designed and built, and how they might affect their users' daily lives. We will focus especially on the following topics:

Technical

- What ways of distributing the output from a system are meaningful? How should one choose from different output devices available, e.g., embedded screens and audio output, personal mobile displays and notification systems, ambient pixel or non-pixel displays?
- How does the situational context (*e.g*., the whereabouts of the user, social situation or relation between people) influence the distribution and allocation of input and output resources?
- What useful ways exist for describing and modeling input and output widgets in such systems [4]?
- How will upcoming technologies that offer short-range inter-device communication (*e.g*., Bluetooth) influence the development of distributed interfaces?
- What technologies exist that can reliably capture situational context? How do we extract information that can be used to make interfaces invisible? What methods can we use to describe such information?
- What methods are there for modeling alternative inputs, considering distributed interfaces and also information provided by situational context?
- How do we address conflicting (models of) user goals?

Social

- How do we deal with shared (public) input and output? Who 'owns' or controls the local 'ether' in shared environments? What about 'access rights' to shared resources in public places, trains, buses, etc?
- How do we attract one user's attention, without disturbing other co-located people?
- Privacy issues - what if the environment records everything we do? Who has access to what?
- How to deal with design, aesthetics and expressions
- How do we handle system breakdowns? How will people be able to correct, or even understand a malfunctioning system, if they did not notice the system in the first place?
- Anticipated social impact, major changes in ordinary peoples' way of life (*cf.* mobile phones, the Web)

GOALS

The main goal of the workshop is to develop an understanding of how distributed UIs in ubiquitous computing can be designed and what approaches are reasonable when creating disappearing interfaces. We will provide a forum for sharing information, results, and ideas on current research in the area of distributed and disappearing user interfaces with its respect to human-computer interaction. Furthermore, we aim to develop new ideas on a structured approach for building such interfaces and also to identify possible obstacles in such an approach.

We hope to bring together researchers and practitioners who are concerned with design, development, and implementation of new interfaces, as well as social scientists or psychologists interested in these issues. In this way we also hope to foster a community of people who are concerned with distributed and disappearing user interfaces.

Results of the workshop and further information will be available at http://www.teco.edu/chi2001ws/

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