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"Where's the Interface?" Enhanced Use Models for Mobile Interaction

Daniel Fallman

Department of Informatics, Umea University, S-90187, Umea, Sweden

dfallman@informatik.umu.se

Abstract: This paper is an overview of my dissertation work, which addresses challenges involved in designing use models, interfaces and interaction styles for mobile technology that go beyond notions and metaphors found in desktop computing. A model of attention and a model of use are presented to explain distinctive requirements of mobile technology. Prototypes are being developed in collaboration with ABB, Scandinavian Airlines System and The Interactive Institute to demonstrate three different use models, where the embodied use model—which blends the gap between the virtual and the physical—is of particular interest.

Keywords: Mobile Interaction, Use Models, Attention, Augmented Reality, Embodiment

1 Introduction

Today, user interfaces for mobile technology such as PDAs, computer tablets and wearable computers tend to mimic those originally designed for and established on the desktop computer. These so-called 'baby face' versions of the interfaces may not work well in mobile use situations and there is little scientific evidence that the same style of interaction, similar information visualization and parallel application functionality to those which prevail in today's desktop computers are also feasible on the move.

This paper describes how the question of designing interfaces for mobile technology is addressed in my dissertation. Section 2 briefly introduces the research questions and the scope of the dissertation. Section 3 is an overview of the planned layout of the thesis. Section 4 introduces the thesis' theoretical frame, while section 5 presents the prototypes being developed as a part of the thesis work. Section 6 is a statement of the current stage and future plans.

2 Research Issues

2.1 A Question of Attention

Common operations required by the user of mobile technology demand a severe amount of attention from the user on three levels; cognitive, physical and social. As for *cognitive attention*, reading texts, pointing, clicking and dragging objects in a completely virtual space is demanding, making the user practically unable to simultaneously play an active part in the parallel physical world. Such interfaces also require *physical attention* in that they make use of styles of interaction and interaction devices also founded in the desktop environment.

Because these devices require both cognitive and physical attention, they also restrict the *social attention* of the users. When using these devices, users are not able listen to, talk or participate in any kind of social interactions. Instead, they are required to focus all available attention on the device, just like desktop computers. Hence, when working with today's mobile technology, the users are generally unaware, or unconscious, of the physical world that surrounds them because the mobile technology itself requires so much of their attention.

2.2 The Physical/Virtual Separation

In effect, we might consider questioning the entire notion of direct manipulation as currently put to use by mobile technology because it does not meet the needs of mobile use situations. The separation of the virtual world, in which the user manipulates virtual objects, and the physical world, in which the user is also required to act, is inherited from previous notions of computing. In desktop computing, it

seems less important for the user to be conscious about the physical world. In fact, most of the office has actually moved into the virtual space, and the desktop computer now constitutes an accepted center of activity. The disconnection between the physical and the virtual may also cause user difficulties in desktop computing, but should be considered even more unfortunate from the perspective of mobile technology use. Here, it is important for the user to be conscious both about the physical and the virtual world. We know this to be true, because the rationale for choosing mobile technology in the first place is that the user is concerned about some issues or properties of the physical world, which makes use of a desktop computer most likely not an option.

3 Overview of Dissertation

Recently, a trend in the Human—Computer Interaction (HCI) community has been to make efforts towards bridging or narrowing the gap between the virtual computerized space and the physical environment (e.g. Harris et al, 1999). The thesis work introduced here strives in this direction, but focuses particularly on use of mobile technology, interfaces and interaction. The assumption is that the gap between the virtual and the physical is of great consequence, and reducing this gap is challenging but essential for designing successful mobile technology. The main approach used is to embed virtual objects in the physical environment by the use of Augmented Reality (AR), where an image or sound is juxtaposed on the physical world and the user perceives both simultaneously.

3.1 Dissertation Layout Plan

The dissertation, planned as a monograph, will be conceptually constituted of three units. The first unit will survey the field of mobile technology, and present the current characteristics of mobile interaction, existing interfaces and today's mobile information visualization. Inheritance from other notions of computing, such as desktop computing, will also be discussed. For instance, how do the metaphors used in desktop computing work in a mobile use situation? Obviously, the perceived and allegedly important gap between the virtual and the physical will be thoroughly analyzed.

The second unit will contain a presentation, discussion and evaluation of the prototypes that are being developed as a highly important part of the thesis work. This part of the thesis is discussed in section 5. The third unit of the planned thesis strives both to build a strong theoretical foundation for developing the prototypes, and as a part of the contributions of the dissertation, add to the existing body of theory regarding use of mobile technology. The next section introduces the theoretical frame.

4 Theoretical Frame

4.1 Towards a Blend of the Physical and the Virtual

A significant and rapidly increasing amount of research and product development is taking place in the field of wearable computing. Typically, a wearable computer is worn mobile technology equipped with input and output devices designed to be available and usable while its user is moving around in the physical world. Recently, wearable computers have started to adopt the concept of AR, as well as Mediated Reality, where an image of the physical world is captured by a digital camera, transformed as needed and then presented to the user in real time. Hollerer & Pavlik (1999), demonstrate an AR based wearable computer that guides its users by use of virtual objects superimposed on the real world. Another way of achieving this goal would be to describe the direction to the users by the use of language. However, spoken language requires cognitive efforts by the user to interpret and act accordingly, and it would be preferable to communicate instead at the sensorimotor level that requires little cognitive interpretation. In Rasmussen's (1986) terms, these efforts would direct users towards skill-based behavior, as opposed to the current mobile interfaces that require knowledge-based behavior, which in turn require attention that restricts them from being active in the physical world.

4.2 Use Models

As introduced in Fallman (2001), the concept of use models is drawn on as a starting point for designing the prototypes. The use models are employed to investigate what consequences different views of mobile technology might have for the activities for which they become used. The hypothesis is that this would also elucidate how they are designed, and explain the way they are understood by users, developers and researchers, as well as why they are used in a particular way by the target users. It captures both how the technology is designed to

support user activities and how the users make sense of the technology that is presented to them.

4.2.1 The Binoculars Use Model

In the binoculars use model, use of a mobile technology resembles the use of a tool in the physical world. It would typically contain one software application used for a specific task, and it would be removed when the job is finished. In a sense, mobile technology that relies on this use model becomes an information appliance, a tool designed and useful for a dedicated purpose.

The potential benefits of this use model are that designers would be able to concentrate on supporting a particular activity, which may reduce development time and cost for products that serve a specific purpose. In addition, the computer hardware used, the physical shape and placement on the body as well as the interaction devices of the wearable computer could be chosen with the specific task and setting in mind. Designers would also be able to provide custom interfaces exclusively for the specific task at hand.

4.2.2 The Eyeglasses Use Model

Mobile devices used as glasses are more personal in that they are often highly customized for and by their user, and hence are not usually used by anyone else. They are in general always on, and worn or carried throughout the day. They are not removed when a specific task is finished, simply because they are not generally designed to fulfill only a single task. Rather, such mobile devices are employed for many different activities, just like a desktop computer. To allow these many activities to be carried out, the mobile devices need to be designed as general-purpose computers, with interaction devices which allow input and output that makes sense for more than one task in one setting. Because of this, the design may be more complex and time consuming, while the result is more flexible in that it more easily adapts to new tasks and changes in the environment than would mobile technology designed to be used as binoculars.

4.2.3 The Embodied Use Model

The embodied use model draws on the phenomenological foundation of how to conceptualize and account for human use of technology provided by Ihde (1990). Ihde indicates that technology mediates human—world relations. For instance, what is perceived through eyeglasses is different from what is perceived by the naked eye, which is to say that use of technology alters the correlation between the physical world and how it is experienced. Ihde terms the most basic relation between humans, technology and the world the embodiment relation. In such, humans directly experience the world through technology. The tool persists between the user and the world, but is not the primary focus of the user's attention, and is to some extent an extension of the user. The tool becomes gradually transparent and will eventually require very little particular attention.

One of the research questions that is being pursued in this dissertation is to what extent it is possible for mobile technology to be used as extensions to human sensory systems, helping us find and filter sensory input that might be too complex or insignificant for the human sensory system alone to recognize. Drawing on Ihde's framework, this is termed the embodied use model.

4.3 Attention and Consciousness

In the dissertation, the model of attention introduced in 2.1 will be further developed and put to use, as will the concept of allocation of consciousness. Hence, the prototypes will be analyzed and evaluated not only in terms of efficiency and in terms of usability, but rather to establish an understanding of the way they affect user experiences. This will be achieved primarily through the three dimensions of physical and virtual experience recognized by Waterworth & Waterworth (in press). These are *focus of attention*—i.e. if users are present or absent—if their *locus of attention* is on the virtual or the physical space, and to what extent they are conscious about processed information, termed *sensus of attention*. It should be less demanding for the users to be able to switch their locus of attention between issues in the virtual and the physical world when those spaces are brought together by virtual objects embedded in the physical world. The interface blends with the physical environment, and in a way disappears for the user—hence the question in the title; "Where's the interface?"

5 Prototype Development

The prototypes address perceived issues in use of mobile technology, and are designed to explore alternative solutions to these problems. Each of the three prototypes introduced below corresponds to a specific use model, and are thus also examples of how each use model works in practice.

5.1 Prototype 1: Mobile IT Support for ABB Service Technicians

The Interaction Design Lab (IDL), situated at the Umeå Institute of Design and part of the Umeå Center for Information Technology (UCIT), sponsors a substantial part of this dissertation work. We are currently working in close collaboration with ABB on several long-time projects. The prototype intended to appear here, as an example of the benefits and drawbacks of the glasses use model, is a mobile IT support system for service technicians. As the eyeglasses analogy implies this system, which builds on wearable technology, should include every possible piece of information and service the ABB service technician needs when working at a customer's site. ABB vends complete factories, including robotics and support software, and is interesting as a case because maintenance of their products is complex, time critical, and there is a substantial distance between the service technicians' offices and the location of their work.

5.2 Prototype 2: Mobile IT Support for Flight Maintenance

During 1999, I conducted a feasibility study for Scandinavian Airlines System (SAS). It has so far resulted in several publications, and we are currently applying for funding for a continuation of the study, which would result in a mobile support prototype system for SAS aircraft technicians. It would build on the binoculars use model, where a hand held tablet computer is used for one or a few specific purposes, e.g. provide a technician with a trouble shooting guide and a manual. SAS as a case is interesting because maintenance is extremely time critical, complex and work is also to a large extent influenced by legislation.

5.3 Prototype 3: BubbleFish

The BubbleFish is a prototype sponsored by and developed in cooperation with the Swedish research organization the Interactive Institute: Tools for Creativity Studio, which is established to develop new media by marrying art and science.

BubbleFish uses AR to perceptualize digital information to demonstrate the embodied use model. This particular prototype assigns a physical location and shape for digital information, e.g. documents. The user is able to manipulate these objects in the physical space as she would with any other physical object, but also to move them into a 'virtual stage' where they can be processed and manipulated by computer applications. BubbleFish strives to give digital information a physical shape and location in the user's environment, and hence to some extent bridge the gap between the virtual and the physical.

6 Future Plans

The work presented here has been in progress for about two years of the planned four, and the initial findings have been considered promising (e.g. Fallman, 2001). Two of the prototypes are being developed at present, while a third needs further funding, on which we are currently working.

These prototypes need to be further developed and evaluated thoroughly. I will also need to found the theoretical framework of use models, attention, embodiment and consciousness in more detail in the existing body of research to be able to put the theory to use more explicitly in the prototypes.

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