Chapter 75
Design of Wearable Computing Systems for Future Industrial Environments

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ABSTRACT

During the last two decades a lot of methodology research has been conducted for the design of software user interfaces (Kirisci, Thoben 2009). Despite the numerous contributions in this area, comparatively few efforts have been dedicated to the advancement of methods for the design of context-aware mobile platforms, such as wearable computing systems. This chapter investigates the role of context, particularly in future industrial environments, and elaborates how context can be incorporated in a design method in order to support the design process of wearable computing systems. The chapter is initiated by an overview of basic research in the area of context-aware mobile computing. The aim is to identify the main context elements which have an impact upon the technical properties of a wearable computing system. Therefore, we describe a systematic and quantitative study of the advantages of context recognition, specifically task tracking, for a wearable maintenance assistance system. Based upon the experiences from this study, a context reference model is proposed, which can be considered supportive for the design of wearable computing systems in industrial settings, thus goes beyond existing context

models, e.g. for context-aware mobile computing. The final part of this chapter discusses the benefits of applying model-based approaches during the early design stages of wearable computing systems. Existing design methods in the area of wearable computing are critically examined and their shortcomings highlighted. Based upon the context reference model, a design approach is proposed through the realization of a model-driven software tool which supports the design process of a wearable computing system while taking advantage of concise experience manifested in a well-defined context model.

INTRODUCTION

The benefit of applying wearable computing systems in modern industrial environments has become evident, especially in environments with a high degree of service and maintenance operations. Such as the design of any software or computing system, a wearable computing system should be designed under consideration of its intended context of use. In recent studies it has been shown that wearable computing systems which were designed without incorporating knowledge of the context of use in the design process usually resulted in systems, unsuitable for supporting the user in his tasks. Internal studies of Airbus/EADS Research revealed this fact and were a driver for our research. A good example for an inappropriate design is a tablet-PC. Observations from our side revealed an interesting fact when carrying tablet-PC's during performance of a mobile task. When used within a mobile task as a digital clipboard, female and male users tend to carry the device in different ways. While women hold the tablet-PC against their hips, men hold the device against their breasts. Children in general carry a tablet-PC in a similar way as female users. These examples indirectly highlight that the context of use was not fully considered during the design process. One reason may be that there is only minimal tool support in the early stages of the design process of mobile and wearable computing systems. Wearable computing systems are, from a technical point of view, even signed by exploiting context information of the real world, and are among other components defined by the presence of context-aware applications (Hinck-

ley 2003). Regarding future industrial environments which tend to be very information-rich, it is likely that wearable computing systems will play a vital role in supporting the user during the performance in his tasks, thus in interacting with his working environment. Context is highly dynamic in these kinds of environments due to the versatility of assigned tasks which take place in several locations. It should be the aim that the user is unobtrusively supported by the wearable computing system during his primary task. As illustrated in Figure 1, the user is continuously interacting with the real world in fulfilling his primary task. At the same time the user is supported by the wearable computing system which seamlessly exchanges information with the real world. An interaction mode change, as it is the case with conventional mobile computing systems, where the user switches between interaction with the computing system and interaction with the real world, is reduced to the minimum.

In order to guarantee the most appropriate design of a wearable computing system, it is crucial that wearable computing systems are designed under consideration of the context of use. Hence, the challenge is to elaborate how context can be incorporated in a design technique in order to support the design process of wearable computing systems at an early stage.

As a starting point of this chapter, we will uncover some basics in research in context, which has been conducted throughout the last decade, especially in relation to context-aware mobile computing. In respect to applying wearable computing systems in present and future industrial settings, we shall emphasize our own

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