

# User-Interface Modelling for Blind Users

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**Abstract.** The design of a user interface usable by blind people sets specific usability requirements that are unnecessary for sighted users. These requirements focus on task adequacy, dimensional trade-off, behaviour equivalence, semantic loss avoidance and device-independency. Consequently, the development of human-computer interfaces (HCI) that are based on task, domain, dialog, presentation, platform and user models has to be modified to take into account these requirements. This paper presents a user interface model for blind people, which incorporates these usability requirements into the above HCI models. A framework implementing the model has been developed and implemented in an electronic speaking bilingual software environment for blind or visually impaired people and in an educational system for children with special educational needs.

**Keywords:** human-computer interfaces, blind user interface model, accessible user interfaces.

## 1 Introduction

Apart from basic human-computer dialogue and design for all principles, adapting a graphical user interface for blind people involves some specific usability requirements: (1) the task has to be adequate given the capabilities of blind users (task adequacy), (2) the user interface has to provide a balance between the 2D access of sighted people and the 1D access of blind people (dimensional trade-off), (3) the user interface has to provide specific access for blind people to all the relevant user interface objects (behaviour equivalence), (4) the user interface has to avoid losing relevant semantic information (semantic loss avoidance) and (5) the interface has to deal with a wide variation in the functionality and programming of the assistive technologies for blind people (device-independency).

These requirements have an impact on all the models used in human-computer interface (HCI) development: the task, domain, dialog, presentation, platform and user models. Based on these requirements and the experience acquired by our team over the years, we have developed user interface model extensions that are presented in this paper. This paper is structured as follows. Section 2 briefly summarizes the related work on user interfacing for the blind. Section 3 describes our proposal for a user interface model for blind people. Section 4 presents the framework for blind user interface development based on the previous model. Finally, section 5 presents some concluding remarks.

## 2 Related Work

There are some user interface management systems (UIMS), toolkits and frameworks that can be used to design dual user interfaces (that is, graphical user interfaces that can also be used by blind people because they combine visual and non-visual modalities) [1]. This same philosophy can be applied to develop applications based on AJAX or other technologies, establishing the mechanisms for implementation [2]. To get an efficient final product, however, some formal interface design and implementation method has to be applied with these tools.

In any case, it is essential, as pointed out by Moreley [3], to examine the fundamental accessibility issues for blind people at length and define appropriate usability guidelines in order to design an interface suited for use by blind people. These guidelines, which should be based on experimental evidence [4], should be formulated not only as general design principles or low-level and platform-specific recommendations, but should also be added to the actual HCI models that define a user interface.

Research has been published along these lines, aiming to define a model that is adequate for blind users and the task they are to perform. For example, Grammenos et al. [5] suggests that the application interaction needs to be modified to make it more adequate for blind users, without affecting sighted users.

This research, aspiring to model user interfaces for blind people that incorporate accessibility guidelines specified in ISO/UNE standards and specific usability requirements for blind people, falls into this category.

## 3 User Interface Modelling for Blind People

The HCI model most widely accepted by researchers and designers is the modelling-based definition by [6]. This HCI model involves creating a number of user interface components. They include the task model, the domain model, the dialog model, the presentation model, the platform model and the user model [7]. The *task model* gives a structured representation of what activities the software user may want to perform. The *domain model* describes the syntactic sequence of the interaction and is implemented as a sequence of windows. The *dialog model* describes the interaction between the different objects making up the interface. The *presentation model* describes the user interface's visual appearance. The *platform model* describes the various computer systems that may run a user interface. The *user model* describes the characteristics of the user or user group.

There are several issues that each model has to account for when developing interfaces for blind users. These issues are derived from the usability requirements for blind people described in the introduction: task adequacy, dimensional trade-off, behaviour equivalence, semantic loss avoidance and device independency (Fig. 1).

The **task model** is a formal description of the service the user accesses. It is organized hierarchically and contains information regarding task activation, its preconditions, postconditions, and the actual task action [8].

In the task model, the tasks described should be checked, during problem analysis, for incompatibility with what blind people can do (for the task adequacy requirement). Blind people cannot do activities that require hand-eye coordination, or