# Mobile Communication & Accessibility for Blind Users

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*Abstract*— Throughout the world, legislations accessibility guidelines have been adopted. However, the technical solutions that have been proposed mainly focus to provide support when users access the *Web applications through desktop interfaces*. Recent technological evolutions in mobile devices can provide a number of interesting and fruitful opportunities for disabled people in order to improve the quality of their life and social interactions. We need to identify solutions for disabled users when they are on the move and they want to carry out important social activities (such as visiting museums). For these reasons we believe that emerging mobile technologies should introduce represent new opportunities for all, especially for users with special needs. In this regard, research should better investigate on how mobile devices, such as PDAs or smart phones, can be used to aid in daily life of blind users.

To better understand the accessibility issues experienced by users of current mobile devices, we will engage in qualitative observations and interviews with mobile device users having disabilities. Our analysis will explore the types of mobile devices currently used by people with disabilities, common accessibility issues that these people encounter, and adaptation strategies that they use to overcome accessibility issues. We are also considering focus groups and diary studies to cover additional mobile accessibility corners.

We will analyze a framework of accessible interaction techniques that can be used to increase the accessibility of mainstream mobile devices. This framework will be designed by qualitative investigation and participatory design for mobile device users having disabilities, and will be implemented as user-installable software for current and future mobile devices.

## I. Introduction

Mobile phones and other mobile devices are quickly becoming an integrated part of our daily lives. In addition to connecting people, modern mobile phones are powerful computing & scientific tools that provide access to information anywhere and anytime. Many current mobile phones enable their users to read or/and send email, browse the Web, track directions and maps, play music & video, and install new applications. As these features become more common, they will change how people seek, use, and share information.

For people with disabilities, mobile phones present both opportunities and pitfalls. Mobile phones provide ubiquitous connectivity that allows people with disabilities to stay in contact with friends, family, and caregivers, to access important information such as maps, directions and to request help if they encounter difficulties. This allows people with disabilities to act more independently in the world. However, mobile phones can also present accessibility issues that make them difficult or impossible to use by some people. Many mobile phones have small buttons that are difficult to use for people with limited mobility, or small screens that are difficult to read for people with visual impairments. In addition, many mobile phones provide feedback in only one format, such as through audio tones or text only, which can present difficulties for people with sensory impairments. Finally, many assistive technologies that people currently use on PCs cannot be easily transferred to mobile devices. These problems are further exacerbated by the fact that mobile phones are rarely used in a static environment, but used in the world, where environmental factors such as noise, unsteady surfaces and inclement weather can harm accessibility.

Many people with disabilities have managed to overcome these accessibility barriers and use mobile devices. Some users have learned to work around accessibility barriers and use mainstream devices, but may be faced with increased difficulty or find some functions of the device remain inaccessible. Other users have adopted devices that are designed for people with disabilities, such as Human Ware's [1] mobile devices for the blind people, people with learning disabilities and people having low vision. Each of these solutions presents problems. Using mainstream devices without accessibility features can be difficult and prone to failure, while customized devices are often more expensive, more difficult to learn, and slower to update than their mainstream counterparts. We believe that there is a third option: To increase the accessibility of mainstream mobile devices by developing new techniques for interacting with and customizing these devices.

For these reasons, we are investigating a framework of accessible interaction techniques that can be used to increase the accessibility of mainstream mobile devices. This framework is informed by qualitative investigation and participatory design with mobile device users with disabilities, and will be implemented as user-installable software for current and future mobile devices.

## II. METHOD

Development of this framework will involve a three-stage research process; each will include significant involvement of mobile device users with visual impairments.

### A. Exploratory Research

To better understand the accessibility issues experienced by users of current mobile devices, we will engage in qualitative observations and interviews with mobile device users with disabilities. Our investigation will explore the types of mobile devices currently used by people with disabilities, common accessibility issues that these people encounter, and adaptation strategies that they use to overcome accessibility issues.

### B. Related works

We will begin to research on accessible interaction techniques for mobile devices. When possible, we will include mobile device users with disabilities as our design partners, drawing on both their experiences with mobile technology and their adaptive strategies for overcoming accessibility issues. These techniques will be refined through iterative design, prototyping, and pilot evaluations, and will result in a prototype mobile phone application that implements these techniques.

### C. System Evaluation

Once prototyping will complete, we will evaluate our interaction techniques with people with a range of abilities to ensure that they are usable and accessible. This evaluation will include users with a range of visual impairments, and will involve evaluation both in the lab and in the field.

## III. FINDINGS (WORK ALREADY DONE)

The impressive influence of mobile telephony on older people lives will be multiplied by the use of combined technologies. Let us show some of the most work done in this area.

### A. Mobile telephones as light terminals to Access to Internet

Even if nowadays Internet is not widely used by blind users, but it is expected that in the near future this usage will increase greatly. Accessibility to World Wide Web (www) is increasing rapidly. And some www pages will be of great help for blind users. For this reason mobile terminals will become very valuable for ubiquitous access to Internet. The palmtop computers that include mobile phones and the mobile phones that include accessibility to Internet, already in the market, are far from guaranteeing the accessibility to older people. The Web accessibility guidelines issued by TRACE Center [2] specify the characteristics that a mobile terminal has to be fully accessible to Internet for everyone.

An important aspect is that when accessing the Internet using a current generation mobile terminal GSM [3] or CMDA [4], the user is immediately restricted to limited display capabilities and reduced bandwidth. The Wireless Access Protocol (WAP) and its associated Wireless markup Language (WML) are very strongly typed, in the sense that every specific type of media embedded in the pages must have an associated type and alternative representation when possible.

With the emerging Bluetooth standard, a user will be able to use her/his mobile phone controlling it from any other device including not only PDAs and notebooks but also Assistive Technology devices such as communicators and wheelchair controllers.

### B. Mobile Telephones and GPS- Tele-guidance

GPS technology permits the localization [5] of the receiver with increasing accuracy. Currently, as a result of the European TIDE [6] Project, Benefon [7] is offering a GSM terminal with embedded GPS receivers. This type of systems will probably become more widespread in the future as being able to cope with the "I am lost". This type of system is also essential if we have to provide health care support for users away from their home. The real benefits for older users will depend to a great extend on their needs being considered during the design phase and, to a very great extend, on the possibility of controlling these systems from other devices using an open protocol.

## IV. FINDINGS (RESEARCH AND DEVELOPMENT)

### A. Software Domain

K-NFB Reading Technology, Inc., a company combining the research and development efforts of The National Federation of the Blind [8] and Kurzweil Technologies [9], Inc., today unveils an exciting product line that will revolutionize access to print for anyone who has difficulty seeing or reading print, including the blind and learning disabled. The company’s world-renowned reading software has been especially designed for and paired with the Nokia *N82* [10] mobile phone to create the smallest text-to-speech reading device in history.

This truly Pocket-size Reader enables users to take pictures of and read most printed materials at the push of a button. Blind users hear the contents of the document read in clear synthetic speech, while users who can see the screen and those with learning disabilities can enlarge, read, track, and highlight printed materials using the phone’s large and easy-to-read display. The combination of text-to-speech and tracking features makes interpreting text much easier for individuals with learning disabilities.

Using the state-of-the-art Nokia N82 cell phone running on the powerful Symbian [11] Operating System with its integrated high-resolution camera, the Reader puts the best available character-recognition software together with text-to-speech conversion technology—all in a device that fits in the palm of your hand. The product includes Kurzweil's unique intelligent image processing software to enhance real-world images captured by a handheld device.

Dr. Marc Maurer, President of the National Federation of the Blind, said: "The knfbREADER Mobile [12] will allow the blind unprecedented access to the printed word, affording a level of flexibility and capability never before available. No other device in the history of technology has provided such portability and quick access to print materials. The NFB promotes equal opportunity for the blind, and this Reader will make blind people dramatically more independent. The result will be better performance at work, at school, at home, and everywhere else we go. This Reader will substantially improve the quality of life for the growing number of blind people and people who are losing vision, including seniors."

Blind users will have access to all of the functions featured in the most advanced cell phones on the market including video and music playback, GPS, wireless communications, photography, e-mail, text messaging, calendar, task functions and many more. The combination Reader and cell phone weighs 4.2 ounces and can store thousands of printed pages with easily obtainable extra memory. Users can transfer files to computers in seconds

### *B. Hardware (Multimodal Mobile Guide for Blind Users)*

#### *1. Description*

The system will be designed for a mobile device in such a way to support location-awareness and usable and accessible interaction for this type of users. Novel solutions will be designed in order to support blind users' interactions. The plan was to exploit gestures with mobile devices to support vocal interaction. The goal is to allow users to freely move and ask information at any time. The type of answer will depend on the users' location and the preferences identified by their previous behavior. The main requests and those particularly detailed will be entered vocally, with the possibility of controlling the output through small gestures in order to go next/back or to different levels of details. Such gestures will be detected through accelerometers connected to the mobile device and can be suitable for blind users who cannot exploit the visual channels to provide such commands. These gestural and vocal interactions will be particularly useful for blind people. The focus is for accessing museum information by a blind mobile visitor but the solution is structured in such a way that can be easily adapted to other similar applications (such as support for shopping or for moving in a complex building). The resulting system will be tested in collaboration with Unione Italiana Ciechi [13] (the Italian Association for the Blind) that has agreed to provide us with a number of blind people for the usability tests. In addition, a young blind woman with Ph.D. in computer science working in the group proposing this research will be actively involved in this project and will be supported by the fellowship.

#### *2. Evaluation Process*

An important goal of this project is investigating how an accessible and usable application based on mobile technologies can be used for improving the social integration for the blind. Therefore, we intend to show how a blind user can interact with a multimodal guide by interacting through voice and gesture. Thus, the evaluation process will be focused on testing a guide prototype designed to be used as a support during a museum visit. To this end, the multimodal guide will be designed in such a way to provide dynamic useful information to enrich the visit. We intend to carry out a user testing with a number of visually-impaired persons (blind and low vision users) in order to collect various feedbacks on the usage of the guide prototype. As our multimodal mobile application refers to a visit in a museum, the prototype developed for a mobile device will be tested in a museum context. The Marble Museum (Carrara, Italy) has agreed to provide us with the basic digital content describing their artworks. This content will be used and manipulated by our application supporting mobile visitors. A set of tasks to be performed will be assigned to the user group in order to evaluate the main features of our application. Tasks will be thought in order to be sure that users test specific features based on gestural actions. Users will be observed during the evaluation sessions in order to gather some information on application usage. In addition, at the end of the evaluation process, a questionnaire will be given to the users in order to collect specific data and impressions.

## V. CASE STUDY (ACCESSIBILITY FOR BLIND USERS: AN INNOVATIVE FRAMEWORK)

In this section we present a recent application of the AURA Framework used for the development of a number (almost 50) of websites for the University of Lugano [14]. In this case the method that was adopted for the generation of the audio version is the generation of two presentations for the same contents: one version for looking at the page and one version for listening to it. The user can easily switch from one modality to the other one. Following Figure 1 outlines the basic elements of the architecture used for this case study. When the user requests a page, the Web CMS (Content Management System), generates the desired page. The content is fetched from a Data Base as an XML file; the page is then generated through an XSL transformation of the XML file. The transformation is different according to the modality selected by the user. The same content can be presented using two different strategies: visual (Figure 3) and oral (Figure 2). This means that the same page can be generated in the two modalities. In Figure 3, the different sections of the layout are underlined)

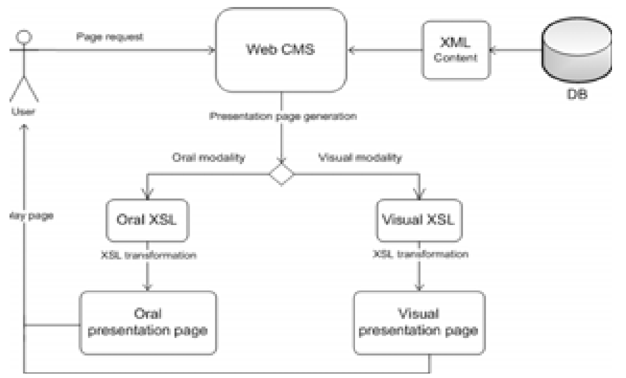


Figure 1: The Architecture for USI websites.

Figure 2 shows the page as generated for users who wants to listen to it (oral modality). According with the example, the "oral page" (Figure 2) is based on few main elements:

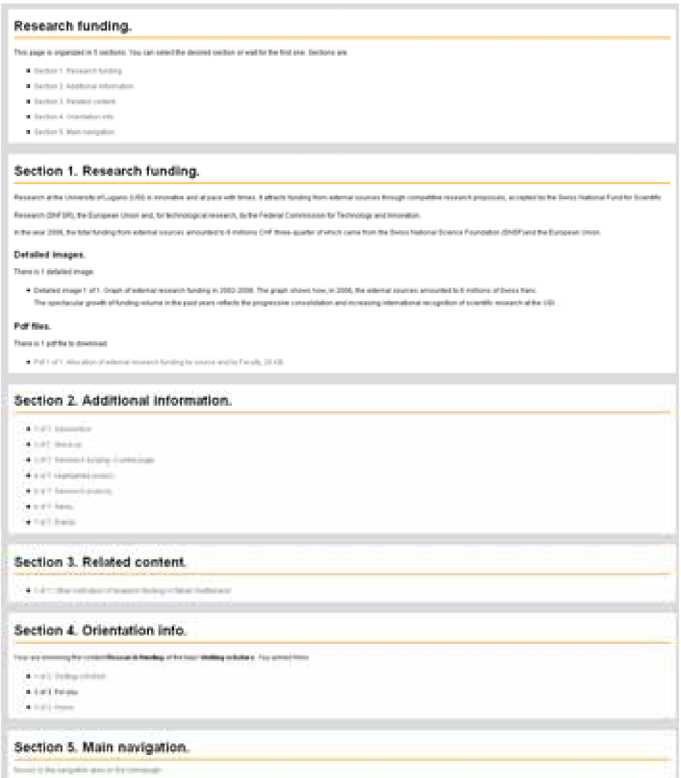


Figure 2: Oral Version

*Sections:* content is organized in sections, identified by headers and easily identifiable by the user. At the beginning of the page there's a special section, the page schema that describes the organization of the sections. The actual content of the page is presented in the main section (Section 1), while links and navigation are part of the remaining sections. This choice allows the user to focus on the content first, and activating links afterwards.

*Sections Organization:* the user listening to the page schema can "orally glance at the page" deciding what the most interesting part is for it. Alternatively the user can just go through the first section (the actual content) and then trough the other sections in sequential order.

*Section and Items:* the organization of items in the section has to be designed carefully. For instance, items of content are subdivided according to "media type": texts, images, files and multimedia elements. The user can quickly identify what s/he wants to hear. This modality is analogous to the reading strategy of a newspaper; sometimes the readers looks at all the titles first, sometimes s/he looks at the pictures, other times starts immediately reading one specific piece of text.

The "understandability" of a list of items is enhanced by the indication of the number of items included in the list and by the progressive enumeration of the elements: this helps the user in creating a mental map with the size of the list and the current positioning within it.


Figure 3: Visual Version

## VI. CONCLUSIONS

Mobile communications technology has a great potential to change the lives of disabled and older people. The industry is starting to take in account this collective as a potential market, mainly due to three reasons: the rising proportion of disabled and especially older people in occidental societies, the possibility of governmental subsidized prices for people with disabilities and, the potential introduction of some of these devices into the main-stream market. But the advantages offered to disabled and older people can only be useful if the design is made taking into account their real needs and requirements.

The benefits that users with disabilities and older people can obtain from mobile access to some services are accompanied by some risks that have to be evaluated and avoided. In this way, the authors propose the inclusion of an ethical and social impact study in every project related to mobile equipment and remote services for disabled and older users, in which possible dangers are pointed out and compensatory actions are described.

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