Mobile ADVICE: An Accessible Device for Visually Impaired Capability Enhancement

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ABSTRACT
The visually impaired have limited access to the world of mobile devices. Our goal was to design a handheld mobile device to overcome limitations such as reliance on visual display and lack of audio and tactile feedback. We built a prototype handheld device using a combination of tactile feedback and auditory display based on preliminary research and testing. Our hypothesis was that this device would provide users with an interface with which they would be able to access advanced functions of a mobile device. This prototype was evaluated by both blind and sighted users. Based on both quantitative and qualitative measures, the results suggest that such a device can enhance the capabilities of visually impaired users of handheld mobile devices.

Keywords
Mobile devices, visually impaired, accessibility, audio feedback, menu navigation, PDA, haptics

INTRODUCTION
A significant and growing number of visually impaired people in all walks of life are discovering and utilizing the benefits of mobile devices. Unfortunately, few alternatives exist to the mobile devices that mainly rely on visual displays and stylus input [2]. The visually impaired must use a variety of expensive, independent devices to address their mobility needs [3].

This report details the development and evaluation of a new, integrated mobile device for the visually impaired, combining functions such as e-mail, mobile phone, personal information management, and applications such as games and multimedia. We believe that the tasks integrated and enabled by the mobile device proposed here can provide a definite benefit for visually impaired users, eliminating the necessity for multiple expensive devices to accomplish the same tasks. It is also hoped that sighted users can find some benefit of the device in certain environments.

CHI 2003, APRIL 5–10, 2003, FT. LAUDERDALE, FLORIDA, USA.
ACM 1-58113-630-7/03/0004.

DESIGN PROCESS
After initial research and analysis, we held brainstorming sessions that led to several divergent design ideas, and discount usability sessions to refine those ideas. The ideas included different types of physical knobs, grooved networks, Braille arrays, and gesture based interfaces for moving through the information space.

The final prototype uses auditory display to convey a menu structure for mobile device functions such as dialing a phone number, checking e-mail, and playing music. It employs a one-handed form factor with the following key controls: a rotating dial for the thumb, which is used to move through various options on a level and can be pushed to select the current option; a button under the dial for the thumb, which is mapped to moving one step back in the menu; and four push buttons for each remaining finger, which are used to perform navigation and application functions. Pressing buttons halfway for at least one second without going to a full press tells the user the button's function, similar to mouse hovering for tool tips in a GUI.

We placed special emphasis on appropriate tactile feedback, such as button clicks and wheel stops. The audio feedback also made use of earcons, which are a short series of unique tones systematically mapped to menu levels and options throughout the hierarchy [1].

EVALUATION PROCEDURE
The primary issues we wanted to study included learnability, physical usability, optimization of feedback, adequacy of conceptual model, minimization of short-term memory burden, and user satisfaction. In order to do this, we collected objective data about task completion time and error rate from a set of benchmark tasks, as well as subjective user satisfaction data. After a short training session, participants performed benchmark tasks using a

"think-aloud" verbal protocol. Most of the objective measures were obtained through transcription and analysis of video recordings for each participant. Subjective measures were obtained on oral questionnaires using five point scales for easier quantification.

For benchmark tasks, two common tasks from normal mobile devices were selected: playing a song and checking email. The two tasks were purposely placed at different levels in the menu hierarchy to allow for a different navigation experience between the two tasks. The user would then have to adapt to the changes in the interface for the two different applications and complete an application-specific step or set of steps. No part of the menu structure was specified in the task description; thus, users could "wander" through the menus to learn the structure, or guess the quickest path and try it. Task order was balanced between groups to mitigate order effects.

Three sighted participants and three visually impaired participants were selected to participate in the study. The sighted users were asked to keep their eyes closed and had their vision of the device obscured by a pillow to prevent their developing a conceptual model based on sight.

Given the lack of suitable devices with which to fairly compare this device, the analytical goal of the evaluation was to show correlations between objective measures (e.g. error rate, time to task completion) and subjective measures of satisfaction.

RESULTS AND DISCUSSION

The measure of the time to complete the tasks shows a mixed result, but overall blind users did take longer to complete the tasks than the sighted users. When comparing error rates of the user populations, blind users made relatively few "slips," but made more conscious errors than the sighted users. A possible explanation is that the sighted group has a more accurate conceptual model of the hierarchical menu structure due to their experience of physically seeing the structure of menus in the past. Sighted users rated their ability to find their location within the menu when using the device slightly lower than did the blind users. We believe that for the blind users who do not normally have the ability to "see" the structure in order to form their conceptual model, the device mapped a physical relationship between menu components that provided a basis for a usable model.

Other than the users having some trouble with understanding the organization at the top level, most participants seemed satisfied and comfortable with the feedback the system afforded them. Participants did not rate the earcons as useful, which is not too surprising given their focus on longer-term usage. All users rated the "half-press" feature as useful, with the blind users rating it more favorably than sighted users. In particular, the half-press feature appeared to provide helpful memory cues when button functions were forgotten.

Subjective measures showed a slight difference between groups in the perceived ease-of-use of the device, with blind users finding the device relatively easier to use than the sighted users. Overall, the participants' impressions of the device were very positive.

RELATED WORK

Other researchers have arrived at similar designs for different tasks. For example, SoundNews is an audio browsing tool for newspaper content downloaded from the World Wide Web [4].

CONCLUSIONS

Based on the experimental results and participant feedback, both quantitative and qualitative, we felt that the design criteria were adequately addressed and consider the basic design conditionally successful. Not all goals were fully achieved with the prototype, but the potential utility of such a device was established. One blind user commented that, "People would just die to have something that could do this." From this study, we learned that the visually impaired desire the same level of functionality in their mobile devices as their sighted peers. The means of providing the necessary enablers for the visually impaired is not simple.

Acknowledgements

The authors would like to acknowledge the Center for the Visually Impaired in Atlanta, the Rehabilitation Engineering Research Center and the Interactive Media Technology Center for their support, and Dr. Bruce Walker, David Nguyen, and other Georgia Tech staff members for their guidance.

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