Systems 3: Multisensory Access to the Graphic Based Computers by Persons Who Are Blind

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Abstract

As personal computers have evolved, they have become an essential tool in the personal, educational, and professional lives of people who are blind. However, the advent of graphics-based operating systems (such as Macintosh, Windows, and OS/2), has caused well-founded concern that computers will no longer be accessible to people who are blind, because these systems use a display technology incompatible with traditional screen access approaches. The Systems-3 prototype, through cooperative efforts and innovative programming, offers a solution to this screen access problem in one graphical environment, the Apple Macintosh and soon the Windows 3.0 environment as well. The prototype system not only allows access to what can be thought of as traditionally textual information (standard word processing files, spreadsheets and databases) but also to information that is inherently graphical in nature (graphs, charts, diagrams, and line drawings).

Problem

With advancing technologies, it is now possible to create graphical computer displays which are designed to be pleasing to the eye and make it easier for people who can see to locate and use information. Most modern operating systems are adopting this form of display. Unfortunately, information presented in a visually appealing fashion is typically more difficult for people who are blind to access than the character-based display found in the MS-DOS software world. Previously, all of the text on the screen was stored in the computer's "display memory" as ASCII text. Programmers quickly realized that they could access and read this text, and a wealth of screen access programs for people who are blind were developed. To do this, a screen access program simply had to take the ASCII text from the screen memory and send it to a speech synthesizer or braille display.

In graphics-based computers, however, information is "painted" on the screen by the application program and the operating system. The result is that there is no "display memory" in the computer containing the characters that are on the screen and their location. Since this leaves only an image which cannot be recognized by current screen reading programs, none of these screen access strategies can provide access to information displayed on graphics-based systems. Interpretation is also confounded by the existence of overlapping windows and by the infinite number of styles in which characters can be presented. In addition, computer-based graphical images such as diagrams, charts, bar graphs and pictures have never been accessible to computer users who are blind.

Systems 3 Description

The Systems 3 prototype addresses these issues and provides access to graphical operating systems for people who are blind. It is the result of a cooperative effort between the Trace R&D Center at the University of Wisconsin-Madison and Berkeley Systems, Inc., with assistance from Apple Computer, Telesensory Systems, Inc., Kurta Graphics Tablets, Articulate Systems, and independent consultant Bo Gehring. The objective was to develop and integrate new approaches of providing full access to graphics-based computers and to graphic presentation of information. Systems 3 builds on outSPOKEN−, by Berkeley Systems, Inc., and provides more complete and faster access to graphics-based environments.

The Systems 3 prototype currently includes the following capabilities:

keyboard access to menus, windows, icons, text and dialog boxes: Systems 3 has all of the standard capabilities of the outSPOKEN- program. These capabilities allow the user to use the numeric keypad on the keyboard to access and navigate through all of the menus; to open, close, move, re-size, find, and read windows; and to access, scroll through, and read documents. Text and icons can be read aloud by issuing a command from the keyboard.

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Off-screen model: Access to the text is provided by an extension to the computer's operating system which monitors all use of the system's drawing tools. Any text which is drawn anywhere in the computer's memory is tracked. This information is used to construct a database of the screen information, which is then used by the access package to provide the user with access to the computer display.

Access to icons: Standard icons are identified and named when they are drawn. Then, whenever they are encountered, the name is read aloud, in the same fashion as letters or words.

Full page virtual tactile tablet: For access to information such as charts, diagrams, floor plans, drawings, etc., a "nonverbal" access technique is required. In order to provide this, Systems 3 uses a Kurta graphic tablet on which a specially designed puck/mouse is used. This puck/mouse has an array of 100 vibrating pins (provided by Telesensory) built in to it. The array provides a tactile representation on the user's fingertip of the image of the region of the screen corresponding to the location of the puck/mouse on the tablet. See Figure 1.

As the puck is moved around the tablet, the user feels the screen image under their finger. In addition, because the tablet has an absolute reference relationship to the screen, the user always has knowledge of the physical location of the mouse pointer on the screen. Whenever the puck/mouse is on the upper right-hand corner of the tablet for example, the cursor is on the upper right-hand corner of the screen. Zoom and magnification capabilities allow the user to move freely about the full screen and to explore any portion in detail. At the same time, the screen reading capability is fully operational; whenever users encounter any text (words, numbers, or icon labels), it is read aloud.

Two-dimensional sound: To further facilitate the location of information on the screen, the sound output from the computer is presented to the user so that words on the left half of the screen sound as if they are coming from the left, and words on the right half of the screen sound as if they are coming from the right (developed by independent consultant Bo Gehring). As the user moves the puck/mouse or uses the auto-reading capability, they get auditory information that reinforces the connection between their hand position and the position of the information on the screen.

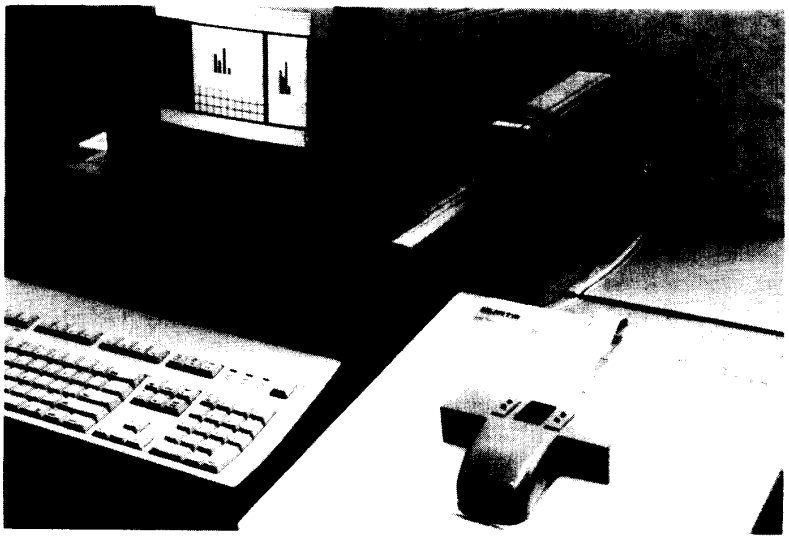

Figure 1 - A tactile array of 100 vibrating pins built into a special puck/mouse and used with an absolute reference tablet provides a "Virtual" full page tactile display. The user can move anywhere on the "screen" and feel the image with their finger providing direct access to charts, diagrams, etc.

Other features: Systems 3 includes other features to facilitate access, including:

use of speed lists based on tactile detents on the edges of the virtual tactile tablet

macros to allow access to multiple commands with a single tablet command

voice input to allow access to special functions and commands without requiring users to remove their hands from the keyboard or virtual tactile tablet (accomplished with Articulate Systems, Inc.'s Voice Navigator)

Future Capabilities

Future areas of development include image enhancement and interpretation of pictographic and other electronic images, enabling complex grey-scale images to be more easily interpreted by people who are blind. In addition, some stereotypic images (bar graphs, pie charts, etc.) could be recognized and described verbally, circumventing the need to tactually explore certain nongraphic information.

Dissemination of Results

As these ideas are refined, descriptions and software tools are being made available to all manufacturers of software for people with disabilities to enable manufacturers to build their own screen access software.

Conclusion

The Systems 3 access package represents a breakthrough in access for users who are blind-not only to a graphics-based computer but also to other graphic information which was previously difficult or impossible to access. It is an example of what can be done when different companies and researchers can work together to address the problems faced by individuals with disabilities.