Audio Technology in IT Education for the Blind

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1. Introduction

At Hatfield Polytechnic, we have a long history of educating blind students in Information Sciences. This paper highlights the current use of audio technology by our blind students and looks at it in the context of the support environment needed by them. Some of the problems encountered by our students are discussed and an idealised set of their hardware and software requirements is developed. Finally the significance of our own "Intelligent Speech Driven Interfaces" project to this area is described.

2. Historical Perspective

Traditionally, computing has been a suitable career for the blind. In a typical environment, a programmer would use a simple scroll-mode terminal or teletype to access a central computer. The scroll-mode terminal is like an extension of the typewriter - text is input and edited on a line-by-line basis, so a braille display which shows a single line at a time is a suitable output medium. Over the past few years, the growing popularity of screen-based editors and windowing systems has meant increasing difficulty of access for the blind user. The increasing domination of wysiwyg (what you SEE is what you get) systems and graphical interfaces has compounded the problem. In addition, the nature and diversity of the tasks performed on a computer has changed significantly.

A comparison of typical computing tasks performed by our Computer Science degree students in 1978 and 1988 serves to highlight the differences: (Specialist applications like graphics have been ignored)

1978
Tasks:

Programming -input and editing of programs on a teletype using a simple line editor. Typically, the programming language was input all in upper-case characters.

Computers Used

a mainframe for high level programming and a micro-processor development kit for low-level work.

1988

Tasks

Programming - input and editing of programs on a variety of terminals and workstations. All systems used support a screen-based editor, some have a line editor. Typically, the programming languages use a mixture of upper and lower case characters and may be case-sensitive.

Applications - access to databases, spreadsheets, expert system shells on a variety of machines.

Document Production - creation of essays, reports and projects using a word processor for text and a drawing package for diagrams.

Electronic Mail - creation and receipt of mail messages from other students and staff.

Computers used

mainframes with two different operating systems. PC's,Macintoshes, Sun Workstations. Microprocessor development kits.

It is plain from the above descriptions, that today's Computer Science student needs to be capable of accessing several different machines in a variety of ways.

3. Specialist Equipment

Last year we had two blind students in the Computer Science department. They used the following equipment to access our computers:

- a Frank Audiodata which provided text-to-speech output via an IBM PC. This could be used in stand-alone mode with PC software (particularly Wordstar for word processing and Symphony for its spreadsheet) or as a terminal emulator ("talking terminal") to access other machines on the local area network.

- a portable Braillink terminal which provided soft braille output, a line at a time.

A braille embosser was available on the network at a remote location for hard copy output.

Most of the Hatfield computers are networked, but the blind student is at a considerable disadvantage if he or she is restricted to a single terminal-type or a single location, since supervised practical sessions are given in a variety of locations and opening times of different laboratories vary. The students often found they could use the Audiodata during the day, but as this is not portable they had to carry the Braillink to the Computer Centre for use in the evenings. They

were not able to access any commercial applications on the Macintosh computers as they could not get past the mouse and icon environment.

3.1 AudioData - discussion

In comparison with a Braillink, there are some disadvantages in using an Audiodata system:

- It is not portable
- It is faster to read a line of braille than to listen to a line of synthetic speech.
- Speech is transitory.
- Synthetic speech is distracting to others (although the use of an earphone solves this problem).

The main advantage provided by the Audiodata is its ability to quickly access any position on the screen and read out its contents by character, word or line. It does not however have any knowledge of the underlying application, so for example it cannot distinguish between the help and text windows in Wordstar nor between the cell boundaries in a spreadsheet. A student who had been using it for a year still had some difficulty in matching the speech and text cursors and was not familiar with all its functions - a more comprehensive on-line help facility would have been beneficial.

The rather poor quality of the synthetic speech did not seem to present a problem as the users quickly became acclimatised to it and were able to understand the output even when spoken very fast, Vincent [4] and others report similar findings. The lack of a facility to add a personalised exceptions file for mispronunciations meant that some words were consistently mispronounced.

The Audiodata was also popular with a partially sighted student who used speech output to browse through files but relied on sight when programming or word processing.

4. Support Environment

In addition to access to a computer terminal, blind students also need other support in their studies. A typical student attends lectures and seminars, takes notes, reads books, produces essays and reports and takes exams, as well as using computers as described above. All of these activities can cause some problems for the blind student, they are dealt with in a variety of ways:

Lecture Notes

Some students have used a Perkins brailler to take notes in lectures, but generally seem to prefer using a tape recorder which is less conspicuous.

Most lecturers produce handouts of notes. If these are on the system they can be output on the braille printer, though they need to be converted into an appropriate format (eg: diagrams removed, tabs and blank lines removed, tables re-written). Handwritten notes are usually read out to the student by one of the team of readers, although we have occasionally been able to employ a typist to input them to the computer for subsequent braille output. Diagrams may be reproduced on swell paper, but usually need to be redrawn or significantly altered to be of use.

The students preferred to have a hard copy of their notes rather than leave them on the system and browse via speech or soft braille output. This may have been influenced by the fact that they did not have access to a terminal at home.

Reading

Students would like to have text books in braille, but very few of the course books are available. Some taped books and manuals are available, but this is not a popular medium for technical material as it cannot be easily referenced in an ad hoc fashion. For this reason a book reader (eg: Kurzweil) was not perceived as very useful. Most of the required reading is done by a team of readers working face to face.

Essay and Report Writing

Students are beginning to make more use of on-line word-processing facilities through the Audiodata but are restricted in that they cannot use it to work at home. They tend to fall back on using a portable brailler and thentyping a transcription.

Exams

Exam papers are presented in braille and may be taken in one of three ways:

- an amanuensis
- dictated to a tape recorder and typed by an audio typist - an amanuensis will still be needed to draw diagrams.
- written in braille and transcribed to an amanuensis.

We have yet to experiment with on-line exam papers, but potentially the answers could be typed directly into a computer with hard copy braille output for the student and typed output for the markers.

5. Future Requirements

Several requirements for improved systems for blind computing students (and probably for blind people in general) have become apparent from the study of current practice, some may be implemented with current technology, and some will be the subject of further research.

There appears to be a trade-off between the generality of any system and the extent to which it can meet the specific requirements of a blind user. For example, the Audiodata provides an interface which allows the blind user to access commercial software such as Wordstar or Lotus 123, it does not however provide extra word processing facilities which might be useful to a blind user. It is essential that blind users are able to access commercial software, or their employment prospects will disappear. Many researchers, for example [5] & [6] emphasise the importance of generality in interfaces, but there is also a case for considering specialist software and systems for individual use.

The mode of speech output may need to be application dependent - Sharp [8] identifies a need for output to vary depending on the application - for example tabs and end of line characters may be significant in a computer program but not an e-mail message - this would imply some intelligence in the interface to recognise the type of application, or at least user-definable options on output.

5.1 Generalisation

An ideal system for a blind user might consist of a portable "black box" with both speech and soft braille output. This would be capable of being connected to any computer with minimal effort on the part of the user, would have knowledge of windowing software and would be capable of providing a textual alternative to icons and a keyboard alternative to a mouse.

The development of ISO standards for virtual terminals will facilitate the introduction of such a system, but obviously only to the extent that particular manufacturers adhere to the standards. Edwards [7] identifies the difficulties of building a general interface to WIMP systems and concludes that at present it may not be practicable.

An alternative is to persuade software writers to build 'hooks' into applications that can be accessed from speech interfaces - in the absence of legislation, this seems unlikely to occur on a large scale.

5.2 Specialist

In addition to the "black box" interface, there is a need for more software designed specifically to meet the needs of the blind. Two examples being developed at Hatfield Polytechnic are given here:

In a study of word processing requirements [1] the following list was identified as important by a blind user:

1. Insertion and moving of paragraphs
2. Deletion of letters and words
3. Searching facilities
4. Automatic centering for headings and footings
5. Changeable margins on both sides of the page
6. Spelling checker/corrector
7. A "quick pleasant bleep" for every change
8. A warning for dramatic errors or possible catastrophic changes
9. Commands for tables of varying sizes - and the ability to fill them in and read them out column by column.

These facilities are all available in one word processor or another, but it is significant that the user was not aware of a system which provided them and found the word processors to which she had access cumbersome to use. A prototype word processor incorporating most of these requirements has been designed to run on a Macintosh using its built-in speech capabilities available through the Macintalk desk accessory [2] & [8]. A further enhancement will be to provide specialist facilities for programming languages.

Another blind user suggested that a "talking diary/telephone book" (Filofax) would be very useful - particularly if it was small enough to carry around. Goodyear [3] describes the design and prototype of such a system. It was also developed on a Macintosh. More work is needed to ascertain the appropriate type of user interface for such a system, but preliminary evaluation suggests that it would be a useful tool even in its present form.

5.3 An Integrated System

If the total working environment of a blind student is considered, we can imagine an "ideal system" consisting of a variety of compatible audio and braille devices and software. This working environment of the future might consist of:

- a portable document/ book reader with the capability of transmitting the text to disc for subsequent output in braille or later perusal via audio

output. Diagrams should be identified and output on some tactile device and/or stored electronically and subsequently output on swell paper with braille labels.

- a personal workstation with network connections for access to e-mail, on-line databases, and other computer software.

- a "black box" interface device as described in section 5.1 to provide speech and braille access to the personal workstation and any other computers.

- a portable and silent device for note taking in lectures

- specialised software for word processing, spreadsheets, personal databases etc..

- a braille embosser

- speech-to-text software for making quick notes and for automatic conversion of tape-recordings into text.

- software for reformatting stored documents for subsequent output in braille.

- software for interfacing between applications, so that for example a standard spreadsheet interface could be learned and all others translated into this form for processing.

The list could go on, it will be different for different types of user. The important points are that there is a need for integration of devices and a need for the consideration of human factors for blind users. Software development is needed which improves the usability of existing audio systems by cushioning the users from the underlying application and by providing specialist facilities for them.

Vincent [4] identified the paradox that technology, which helps to solve problems experienced by blind people can also widen the gap between those with and without a visual handicap. The gap is still there, if not widening, and a lot of work is needed to close it.

6. The Hatfield Polytechnic 'Intelligent Speech Driven Interfaces' Project (ISDIP)

In this three-year NAB funded project we are looking at the applicability of artificial intelligence to speech based interfaces. It may be that the requirements of a generalised speech interface can best be served by the utilisation of an intelligent interface management system.

A study of office tasks and dialogues will provide information for an intelligent knowledge base which will be used to enhance both the speech generation and recognition processes. A user model will be built into the system and will evolve

according to a user's preferences and pattern of work. Each application program will be modelled by providing a set of details of the application and its modes of use.

The human factors of speech based interfaces will be considered and an iterative development cycle will be used to produce demonstrators of typical office applications using speech input and output.

The particular relevance of this project to the blind is in three areas:

- the development of bespoke applications using speech output

- the utilisation of the intelligent knowledge base to enhance the text-to-speech output by:

    i) automatically adjusting the type of output according to the type of application (eg: speech structure for a programming language)

    ii) providing a structure for the synthesis by concept of information not held in a textual form (eg: in databases)

- the investigation into the practicality of developing a generalised speech interface.

7. Conclusions

In conclusion, further work is needed to integrate audio technology into a set of equipment (hardware and software) which will provide blind people with access to current systems. There is a need for portable general purpose devices and for specialist applications software. Ideally, conversion software will be developed which can enhance the usability of commercial applications by presenting them in a standardised interface format - there may be a requirement for intelligent knowledge bases to provide appropriate models of application and user.

Employers need to be convinced that blind people can cope with the variety of interfaces in use in applications today - to this end it is important not only to develop appropriate tools but to make them available to students so that they can develop marketable skills. The Manpower Services Commission will provide equipment for blind people in employment, but there is currently NO mechanism for providing blind students in Higher Education with the equipment they need - they must rely on the goodwill and budgets of the individual organisations. A new policy is urgently required to ensure that students can gain access to appropriate equipment.

This paper has concentrated on the needs of blind Computer Science students - a tiny minority of the blind community, but important because they are amongst the first users of new technology. If they have difficulty with it, the chances are not good for the non specialists.

8. References

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