Attracting students through assistive technology projects

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Abstract

Curtin University has a Centre for Assistive Technologies (CUCAT) that endeavours to create artifacts that can support and improve the lifestyle of people with disabilities, in particular, those with vision impairment.

Ideas generally come from university staff or from students. Actual implementation is the focus of projects within the Department of Electrical and Computer Engineering. Students are attracted both by the "hands on" creation of real artifacts and the "good feelings" that they get by contributing to these developments. Real world problems are faced and design requirements addressed where final cost of a product is a significant limitation on potential utilisation. In general, people with physical disabilities have limited income so expenditure on artifacts/products is a major decision. Cooperation and teamwork across multiple disciplines – communications, electronic, mechanical, mechatronic, and computer engineers - is necessary and for a potential product to be ultimately feasible it must meet a global market so international standards must be met.

This paper discusses the types of project that have been implemented, the challenges faced and our observations of the impact involvement has had on the students themselves. It has been found that students are attracted to and often seek to involve themselves in this field.

Keywords: assistive technology, vision impaired, design projects

1. INTRODUCTION

Curtin University has a Centre for Assistive Technologies (CUCAT) that endeavours to create artifacts that can support and improve the lifestyle of people with physical disabilities and, in particular, those with vision impairment.

Concepts for implementation generally come from university staff or from students. Actual implementation is the focus of a significant number of projects within the Department of Electrical and Computer Engineering. Students are attracted both by the "hands on" creation of real artifacts and the "good feelings" that they get by contributing to developments that can ultimately improve the lifestyle of people with disabilities. In these projects real world problems are faced and design requirements addressed where final cost of a product is a significant limitation on potential utilisation. In general, people with physical disabilities do not have significant disposable income so expenditure on artifacts/products is a major decision only entered into if significant advantage may result from ownership. Cooperation and teamwork across multiple disciplines – communications, electronic, mechanical, mechatronic, and computer engineers - is necessary and for a potential product to be ultimately feasible it must meet a global market so international standards must be met.

This paper discusses the types of project that have been implemented, the challenges faced and our observations of the impact involvement has had on the students themselves. It has been found that students are attracted to and often seek to involve themselves in this field.

2. ASSISTIVE TECHNOLOGY PROJECTS

A wide range of assistive technology projects have been proposed, designed and implemented by engineering students at Curtin University. These have been mainly designed to support people who are vision impaired and may be broadly classed as supportive products (such as Braillers) and lifestyle products (such as handheld colour sensors). Supportive products include those designed to assist in making activities easier or even feasible for vision impaired people and those that enhance their ability to obtain employment. Lifestyle products provide facilities which are not a necessity for living but can simplify life or assist the user.

The following sections provide brief descriptions of assistive technology projects undertaken through the Department of Electrical and Computer Engineering at Curtin University.

2.1 Curtin University Brailler (CUB)

The Curtin University Brailler (CUB) is a Personal Digital Assistant (PDA) for vision impaired people[1][2]. Its objective is to make information in different formats accessible to people with limited visual ability. This project has been approached through team design over several years with new students having to understand the work of their predecessors and to progress the development or if necessary redirect work to better potential solutions.

The device we have been developing is an ARM processor based linux machine that incorporates a “docking station” that produces hard copy Braille. Unlike existing commercial systems the intention is that the software used be open source and include a usable/accessible development environment and also that the hardware be open. This will allow for other developers to build additional functionality such as Braille displays, GPS maps/ devices and so on.

The system consists of several modules including a text-to-Braille translation system, a Braille keyboard controller, speech synthesis and a Braille embosser. The translator implements Blenkhorn’s algorithm in hardware, liberating the microprocessor to perform other functions. The Braille keyboard controller along with a low cost keyboard provides users with a note-taking function as shown in FIGURE 1. The system is capable of monitoring sensors to control motors and an embossing solenoid in order to emboss Braille onto paper. The system is also capable of receiving characters from either a standard QWERTY or a custom Braille input keyboard and displaying these typed characters onto an LCD screen. In addition the keyboard utilises chords and function keys to control Brailler functionality, for example speech rate, volume and Braille translation grade.

A speech synthesis function is desirable for any modern Braille typewriter. This project studies the feasibility and approaches to develop speech recording and synthesis application on the Open Multimedia Application Platform (OMAP). It investigates the software, hardware environment, an applicable model of a speech synthesis system, and introduces two proof of concept programs to demonstrate recording and synthesis operations.

The text to braille translator part of the project has been implemented using Field-Programmable Gate Arrays (FPGAs)[3]. Distinguishing this project from most commercial software-based translators, the circuit created is able to carry out text-to-Braille translation in hardware. The translator is based on the translating algorithm, proposed by Paul Blenkhorn. One additional advantage of this system is that other Braille tables may be loaded on demand in real time, allowing the mixing of multiple language and/or Braille grades within a single document.

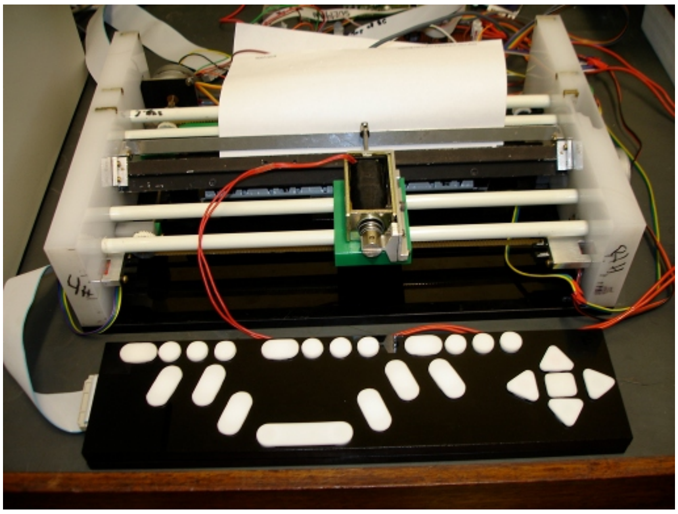

FIGURE 1: The keyboard and embosser mechanism

2.2 Wireless headset communications

This project was sponsored by a major company with a call centre requirement. A wireless headset has been developed for vision impaired persons to use in multi-user environments. In an environment such as an office, background noise can often affect the performance of telephonists especially for the vision impaired. As they rely more heavily on their sense of hearing and touch, coupled with the fact that they utilise multiple devices such as an exchange (PABX), note taker and perhaps a directory, the role of the multi-channel amplifier is to improve the quality of the incoming signal to the telephonist while prioritising the inputs from all the devices[4].

This project required the implementing of features such as noise cancellation, automatic gain control and normalisation using a digital signal processing board. Separate hearing channels are used for telephony and ancillary information from the computer system. A major advantage for the vision impaired is the ability to move around their working environment without consideration of wiring connections to their computer. A prototype is shown in FIGURE 2.

FIGURE 2: The wireless headset prototype

2.3 Ultrasonic white cane

The white cane is the most common mobility aid used by the vision impaired. It is by far the most economical method employed to aid users to move about independently and confidently, however, it has several limitations. The normal white cane's maximum detection is one step ahead and it has no ability to detect overhanging tree branches. Potholes or stairs are easily missed by the cane's side to side motion and this may lead to the blind user stepping off unnoticed edges.

This project used ultrasonic sensors and integrated them as an additional facility gadget onto the white cane to overcome the limitation previously described[5]. A Mitsubishi Microcontroller M16C/62 was used to generate the transmitted ultrasonic signal needed for the detection of any overhanging objects and significant surface drop off. The received signal was then processed by the microcontroller for distance measurement based on the time-delay between the transmitted and received ultrasonic signals. It provides audio signal as feedback to the user using volume and pitch to encode the reflections detected. Importantly, this device gives warning for two alert conditions only, waist to head height obstructions and drop off conditions. This means that the user is not distracted by continual audio feedback and may concentrate on environmental conditions such as vehicular traffic and other important audio cues.

2.4 Accessible software development (iNETSIM)

Vision impaired students studying computer networking need to be able to simulate networks and understand the consequences of their choices. The use of the VoiceOver facility on the Macintosh computer together with the development of a network simulator which maintains network information in a tabular (as well as graphic) form facilitates learning as shown in FIGURE 3.[6][7][8][9]

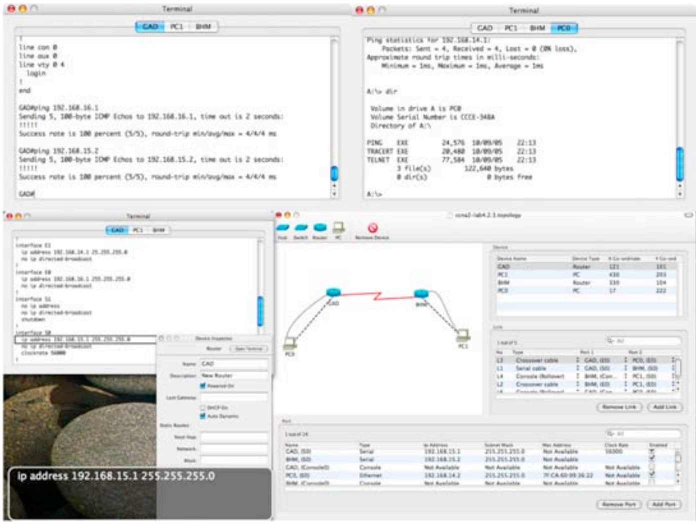

FIGURE 3 iNetSim with command line terminal session open. The text in the floating window shows the text read by VoiceOver

2.5 Talking books

CUCAT has put together some Macintosh tools for working with digital talking books based on student project developments. These are free and can be downloaded at: http://www.cucat.org/projects/dtbtools/

A number of products have been created and made available.
(1) DTB2iTunes - This Macintosh application will combine the audio of full audio DAISY digital talking books provided that the audio files are named in playable order, in MP3 format and are not encrypted. You can make

them into either MP3 files or iPod audiobook M4B files.
(2) DTB22LaTeX - This Macintosh application will create a LaTeX file which can be used to produce a large print PDF document from a DTBook XML file. This application provides a user interface to Christian Egli's XSLT code.
(3) TextOnlyDTB - This Macintosh application will create a text only DAISY/NISO digital talking book from full text/full audio DAISY/NISO z3986 file sets.
(4) Olearia is a project to bring the versatility of talking books (Both Daisy and others) to Mac OS X. Currently Olearia will open and play Daisy V3 (ANSI/NISO Z39.86-2005) books and DAISY version 2.02 books with audio content. It features an easy to use intuitive interface with full navigation of the book structure as well as preference management on a per book basis, playback speed and volume adjustment on a per book basis, fast forward and rewind of audio content, choice of normal or high contrast icons for low vision users, and full VoiceOver compatibility.

2.6 Music scanner

The music scanner project produced a software application designed and implemented to improve sheet music readability for low vision musicians. It is capable of creating a movie of scanned sheet music images moving across the screen while giving musicians the ability to dynamically vary the playback speed of the movie. It is also capable of varying the visual size of the movie to suit the individual needs of each musician.

2.7 Colour recogniser

A prototype of a hand held battery operated colour sensor device has been developed which is able to recognize 64 different colours. The design uses a combined Red-Green-Blue LED to illuminate a surface. The level of reflected light from these primary colours is measured with a photodiode. The output current of the photodiode is amplified and measured. The operation of the system is controlled by a Mitsubishi M16C/62 microcontroller and the colour is spoken through a ISD2548 chipcorder speech chip. This colour sensor device is suitable to vision impaired people as it provides them with a facility to perform basic colour recognition tasks.

2.8 Currency identification

One of the difficulties encountered by people suffering from a high degree of vision impairment is the identification of Australia's polymer note currency. While the notes have length differentials between successive denominations, the current methods for note identification are often expensive, difficult to use or are not portable. This project created the design for an inexpensive, portable and accurate currency identification device for use with these notes. [10][11]

2.9 A portable Braille recognition device

This project examined the use of a floating CMOS Array Camera sensor as a means to develop a practical Portable Braille recognition device. The project used the Omnivision OV7620 CMOS Camera connected to a TI5510 Digital Signal Processor as a method of eliminating issues concerning skew and paper damage when scanning a line of Braille text using a linear array. The design created proved that current DSP and Camera technology is fast enough to capture an adequate amount of frames for analysis. The prototype is shown in FIGURE 4.[12][13]

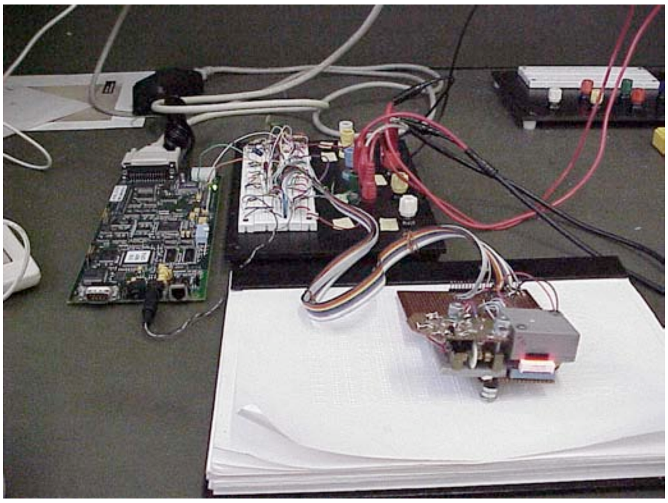

FIGURE 4: The Braille scanner

2.10 Sign identity and guidance

The Multilingual Infra-Red Sign Identity and Guidance System (MIRSIGS) is a system comprising two devices, a hand held controller/monitor and a sign add-on device. It is designed as a navigational aid to surrounding landmarks and signs. Upon request by the user, signs will identify themselves using a unique identity codeword. Upon receipt by the handheld device, the codeword is processed and translated into a description and is then played back using a speaker or headset. A guidance tone is also emitted by the sign add-on device, and gets played back at the hand held device. Depending on the direction, proximity and distance to the sign, the tone level either gets stronger or weaker.

2.11 Sign language recognition

There have been several projects oriented to extracting sign language information. One project was designed to provide hand tracking and facial feature extraction for the purpose of Australian sign language translation. In order to produce the correct translation five inputs are required by the translator. These are hand shape, orientation, location, movement and facial expressions. These projects have investigated the development of real time systems to track the hand position and roll through the use of optical trackers and the development of a visual feature extraction system.

A second project used a single-chip microcontroller programmed to gather data via contacts indicating which parts of the hands are touching. This data is then transmitted back to a host computer where it is combined with data from the P5 Virtual Reality glove. An algorithm then filters the composite data, in real-time, to identify the structure and movement characteristic of Australian Sign Language (Auslan). As signs are recognised the relevant word is output.

2.12 Classroom aids for the vision impaired

Two projects have addressed the needs of vision impaired students in the classroom, the first using a hardware approach and the second software. The first project covered the design, image acquisition and image processing techniques of a Low Vision Image Enhancement System (LOVIES). LOVIES is a portable low cost CCTV based device which can be used in a class room environment to display far away objects, diagrams and texts on a screen next to the user. This enhancer incorporates most of the useful image enhancement techniques with a purpose designed user input interface, which allows combination of two or more of these techniques.

A second project provided the basis for the design, development and testing of iView, a software-based classroom aid for the vision impaired. The software is targeted for the Macintosh operating system, Mac OS X. Included in the work was a review of existing aids that were available for people with low vision and some of the accessibility options offered by both Apple and Windows operating systems. It is also capable of captioning (taking notes) and real time zooming.

3. CHALLENGES FOR STAFF AND STUDENTS

The first challenge faced by staff and students working on assistive technology projects is to identify the real problems faced by the vision impaired when dealing with a product whose intent is to simplify and/or enhance their lives.

These can be simple, such as the decision in the design of a hand held device whether to use a push button power switch or a slide switch, or complex, such as how to provide network description and interconnection information for use with a network simulator.

These are often best resolved by the vision impaired themselves and we are fortunate at Curtin that our involvement with the education of vision impaired people in the Bachelor of Technology (Computer Systems and Networking) and in support of the Cisco Academy for the Vision Impaired (CAVI) which provides friendly keen contacts always willing to discuss and evaluate potential solutions.

The second challenge is inexperience. The students are generally in their fourth year undergraduate Bachelor of Engineering. Their courses have given them skills such as an understanding of UML to specify systems and high level languages for coding but less exposure to real world problems. The project is the capstone unit of their course and the students are prepared to put in time to be successful but the Pareto Principle applies if there is inadequate support and direction from staff in the early stages.

The next challenge is for the students to believe in themselves. Often the projects are more than can be handled by one student and may also need two or more years to bring to fruition. Consequently they need to come to understand and appreciate the contributions of others and to believe that they can make a useful contribution to the overall development even if this means that they are themselves only tackling a component of the system.

Another challenge is documentation from both a comprehension and creation viewpoint. What did a previous contributor to the design really mean by what he has written? Why hasn't s/he used the UML (or equivalent) formalism as the basis for system description? How do we create documentation so that people following on can get the best value from our contribution to the development?

For some projects an important challenge is to work in teams. Experiences with team work within the normal course units can help but finding that failing to achieve in time what has been promised to the team and seeing the impact on further progress of their peers can be a salutary experience for these students.

For staff members the challenge is to assist students to overcome their starting points and to make meaningful advances in the design without taking over and doing it themselves. Often the staff member approaches a design with a particular solution in mind and it is often difficult not to impose that solution on the students undertaking the projects. In general, if the staff member/supervisor assists in getting the specifications right and then supports the students in investigating alternative solutions s/he may well find new and possibly improved solutions presented by innovative student designers.

Ensuring that students appreciate the needs for standards and address the issues raised in meeting the requirements for product design for potential international application is another challenge for the staff members involved.

The differing requirements of the large range of projects have lead to differing challenges. For example, the Brailler project had to look at a long product life which has been the case with all previous commercial Braillers but computer technology has a relatively short life. In particular the appropriate storage size rises fairly quickly with time. The implementation arrived at after considerable investigation is to use internally pluggable flash drives which which can be upgraded with minimal skill.

4. INVOLVEMENT

The question arises "Does the involvement of staff in development of assistive technologies attract students? Curtin has attracted a very positive image from our involvement with assistive technologies but we cannot directly attribute any student entry to this, however, we do find that project students often request involvement. We do not have many female students in our courses but have found for several years that most have chosen to take assistive technology projects.

Subjectively staff have indicated that, in general, there is a greater commitment to success by those students undertaking assistive technology projects. Initially it has been observed that the sighted students are reserved in the presence of vision impaired people but this is soon overcome by continued common usage of the same laboratory.

5. CONCLUSION

The field of assistive technology provides a niche area for development as vision impaired people, in general, do not have significant spare disposable income so what they buy has to be useful and economic.

Students are generally attracted to projects which have social value and providing a range of projects in the assistive technology area has been very positive for the Department of Electrical and Computer Engineering at Curtin University. Provided there is good staff support the development of these products has been a very positive development attracting the best students. It is anticipated that similar characteristics would be observed in other universities following similar ideas.

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