Handicaps' DIGEST

Computer Access for People with Physical Disabilities

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"IT can be exploited to provide pre-vocational and social skills training to the disabled and to assist them to participate in a normal work environment. IT will even enable the homebound physically disabled to work, learn and have access to shopping and banking facilities in their homes. However, an important first step is to ensure that they, the disabled, have easy and ready access to IT."

— David Chan.

Introduction

The National Computer Board (NCB) in its IT2000 Report provides a vision of Singapore as an Intelligent Island in the next century. Information technology (IT), which combines the technologies of computing and telecommunications, will be embraced to enhance the potential and to improve the quality of life of people living in Singapore. The IT2000 Committee did not forget the disabled. In fact, the Committee urged that "Information Technology should also be applied to improve the quality of life for those who are afflicted by disabilities, senility or illnesses [NCB, 1992]".

"Children with disabilities have the same right of access to education as other children. They require special assistance to fully utilise their potential and abilities for independent living [ACD(a),1988]." However, children with disabilities have learning difficulties and IT can and should be exploited to ease the learning difficulties; it can help learners to overcome their difficulties. Educational possibilities are greatly enhanced by teaching methods using computers. Disabled children can also have access to the normal school curriculum through the use of IT.

There is also a need to bring people with disabilities into the economic and social mainstream. "Properly trained, disabled people can make useful contributions to the work force [ACD(a),1988]." But they require "training opportunities to enable them to undertake work best suited to their abilities and achieve maximum work potential [ACD(b),1988]." IT can be exploited to provide pre-vocational and social skills training to the disabled and to assist them to participate in a normal work environment. IT will even enable the homebound physically disabled to work, learn and have access to shopping and banking facilities in their homes. However, an important first step is to ensure that they, the disabled, have easy and ready access to IT.

A study was conducted by a team of CCS staff in September/ October 1993 to find out how extensively computers are being used by the physically-disabled in Singapore. As part of this study, the team visited a total of twelve special schools and centres in Singapore. The team ob-

served how people with disabilities, in particular those with physical disabilities, use computers and the problems they encounter. The findings of the study team are reported in this paper. This paper also examines the broad range of assistive computer technologies and special interface devices available to provide easier computer access. Some of these are already being used in the special schools and centres the team visited. Current research and development work in the area of assistance software technologies are also briefly presented.

The Physically Disabled

Physically-disabled people are unable to move normally or to exercise proper control over movement. Some are born physically disabled. Physical disabilities can arise from congenital disorders like cerebral palsy (spastics) and spina bifida which affect the skeletal, muscular and nervous systems. Some had been involved in serious road or industrial accidents which resulted in injury of the brain or spine and which led to physical disabilities. Others contract diseases like poliomyelitis, stroke paralysis and multiple sclerosis. It has been reported that accidents and diseases are two of the major causes of disability [UN,1986]. There are also those who suffer from disorders like arthritis, parkinsonism and muscular dystrophy. Many have problems with access to written material and writing. They also have recreational difficulties. Many severely physically-disabled people also have mental (psychological or intellectual) or sensory (speech, vision or hearing) disabilities and therefore have more handicaps and frustrations.

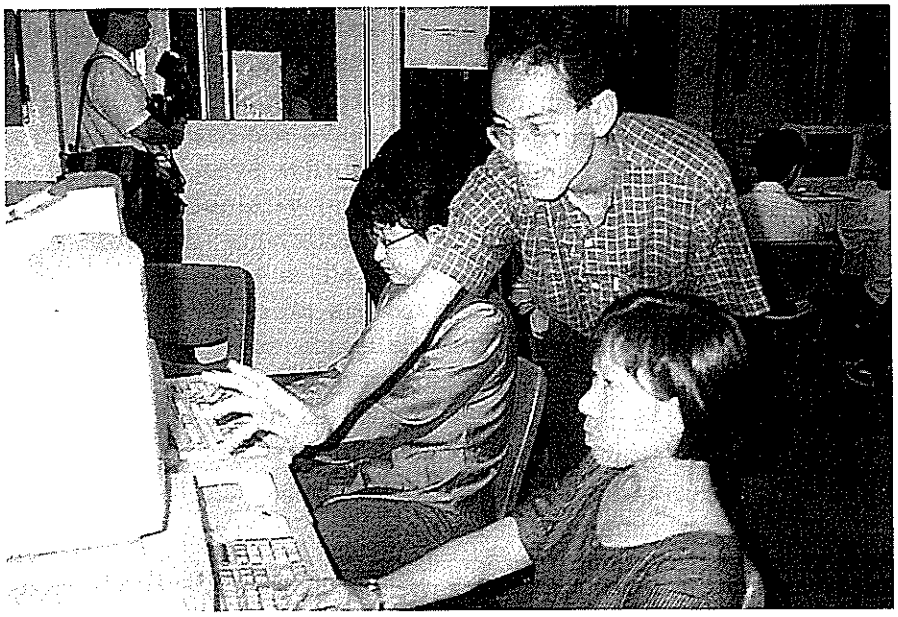
Use of Computers by the Physically Disabled

A study on the use of computers by the disabled was carried out in October and November 1993 by a team from the Centre For Computer Studies, Ngee Ann Polytechnic. The team visited eight special schools/ centres for people with disabilities; two residential centres, one for the physically handicapped and the other for the intellectually disabled, and two employment centres. It was found that the usage of computers is not extensive and that computers are used mainly for office administration purposes. Only a few special schools are using computers for education, training and recreation. Although a general survey of the use of computers by the disabled was carried out, this paper focuses on the use of computers by those in schools and centres for the physically disabled.

The common aim of the special schools and centres for the physically disabled is to help those under their care to live as independently as possible. Software are already being used in the education, vocational and recreational programmes of these special schools and centres. However, many of the Computer-Aided Instruction (CAI) packages that are bought off the shelves require the use of the standard keyboard and monitor. Instructional software that allow the use of special interface devices instead of the keyboard are available but they run only on BBC microcomputers. Since computer resources are limited, usage is controlled. Some of those who are keen to learn or play with computers have difficulties using the standard keyboard for interaction but special interface devices are not available in all the schools and centres. Individual assessment (and regular re-assessment) of those needing computers as an aid to communication or curriculum access is important.

The study team did not detect

Mr David Chan, Director of the Centre for Computer Studies, delivering his paper on, "Computer Access for People with Physical Disabilities" at the seminar.



Two HWA members are undergoing software application training during the 4-day workshop at Ngee Ann Polytechnic.

any anti-technology attitude amongst the teachers in the special schools and centres. This could be due to the fact that most teachers in special education are accustomed to assistive devices and were exposed to a wide range of innovative rehabilitation techniques and approaches during their training. However, not all teachers are familiar with the use of IT for special education needs. The level of availability of special training resources, including computers and special interface devices is therefore not a reflection of the teachers' level of enthusiasm; it depends very much on the schools' ability to raise enough funds. The teachers also do not have enough information and technical support in this area of activities.

Difficulties in using the Computer

The keyboard and the monitor have been and still are the main channels of communication between people and computers. People with disabilities will find these channels difficult if not impossible to use. People with physical disabilities affecting the locomotor system, that is the spine and upper limbs, will have problems using the keyboard. If they also have poor vision they will have problems viewing the display on the computer screen. For those whose hearing is impaired, auditory prompts like beeps and tones are useless.

Some mildly physically disabled persons are able to use at least one of their fingers to press the keys on the keyboard although it is cumbersome to do so. Others who are unable to use their finger, have to resort to using a headstick, mouth-held pointing device or even their toes for pressing the keys. For those who can use the keyboard for input, ways and means should be found to help reduce input errors and fatigue.

The keyboard and screen should be correctly positioned in order to reduce physical exertion and fatigue. The best position for one is not the best for all. It depends very much on which parts of the body the individual has some control. The height and angle of both the keyboard and screen, must always be adjusted to suit the individual, regardless of whether he is on wheelchair or not. For someone who has to lie on his back all the time, a screen may even have to be mounted overhead.

Assistive Software Technology

Software have been developed that provide control of the keyboard operations. These are usually utility programs that have to be loaded into the computer before the application software is used. For example, it is impossible for those who can only type with one finger, a mouthstick or a headstick, to use modifier keys (SHIFT, CTRL and ALT keys). However, with the use of StickKeys, one of the utilities provided in a package called AccessDOS (developed by the Trace R&D Centre at the University of Wisconsin-Madison), the one-finger keyboard operator is able to press a modifier key and then another key, in sequence rather than at the same time. Similar utilities are also available for those using Microsoft Windows [Novak,1992].

The study team also observed that those with tremors always press unwanted keys unintentionally. This can generate a lot of frustration since the unwanted characters have to be

erased from the screen. A keyguard placed on top the keyboard and the use of stiffer keys do provide some help. Keyboard control software are available that ignores keys which are pressed accidentally or for a short time. The activation time is lengthened, that is the keys must be held down for a while before they will be accepted. Those with tremors also tend to bounce on the same key when pressing it. Utilities are also available that will ignore such keybounces.

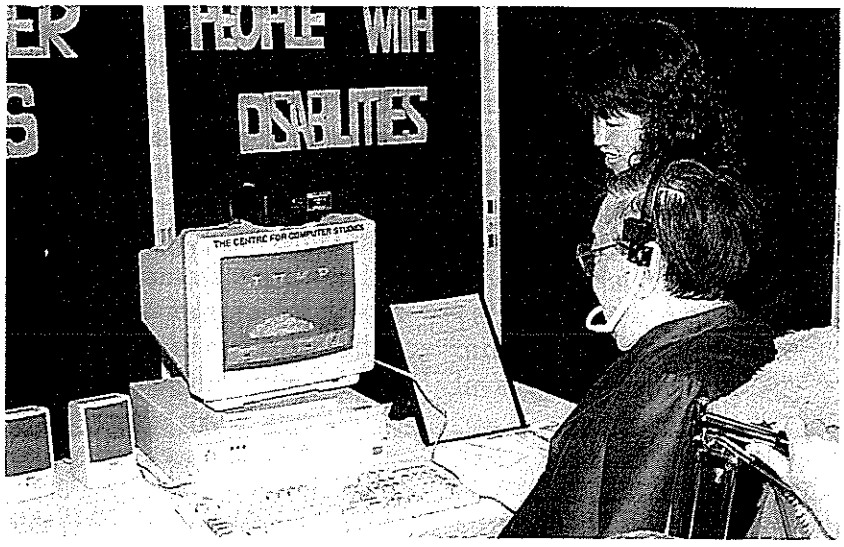
Many applications require the use of a mouse for pointing and selection. Those who have impaired control of their hands have difficulties using a keyboard, let alone a mouse. However, with the help of assistive technology in the form of a software utility, the keys on a numeric keypad can be used instead to move the mouse cursor and to click the mouse button. Dragging can also be done by first pressing a key to lock the mouse button down.

The availability of such software utilities is good news because they provide full and easy access to virtually the whole range of microcomputer software (including multimedia applications) available in the market. This would mean that physically disabled children who had difficulties using the keyboard can now have access to instructional courseware, like those produced by the Curriculum Development Institute of Singapore (CDIS), which have in the past benefitted only children attending normal schools. The disabled can also be prepared for employment in the office if they can have access to common application software for the office environment. This would result in greater success in education for disabled children and greater employment opportunities for them in the future.

Special Interface Devices

The study team also observed that severely motor-disabled users were not able to use the keyboard or mouse at all. This group is therefore not able to access the commonly used applications available in the market. However, they can have access to software that have specially designed interfaces and that make use of switches as input devices. Children in the Margaret Drive Special School and Spastics Children's Association have access to learning packages and games software that allow the use of thumb switches, foot switches, breath-controlled switches, squeeze levers and pull handles for interaction with computer. These switches basically allow the user to select items from the screen without using the keyboard or the mouse. The items are scanned (highlighted one at a time) and the switch is used to start and stop the scan. When scanning stops, an item is selected. The scanning speed can be adjusted according to individual needs. A switch can also be used together with an indirect pointing device worn on the head.

The children are also using the concept keyboard which is touch sensitive. The concept keyboard which can be overlaid with characters, words, phrases or pictures replaces the conventional keyboard. There was no sign of touchscreens being extensively used although the prices of such input devices are now relatively low. Touchscreens allow the user to point directly, using a finger, at what he wants on the screen.



The Editor, Mr Johnny Ang, trying out the directional light-beam and breath-controlled input device with assistive software developed by the students at CCS.

Although touchscreens have been dramatically improved in the past few years [Schneiderman, 1992], there is still an inherent disadvantage; the user has to raise his arm and this can cause fatigue. Voice-activated systems are already available in the market to those without speech impairment but the study team also did not see these being used in the institutions visited. Currently, these systems are still very much speaker-dependent and have to be 'trained'; the user is required to repeat the full, albeit small vocabulary of 100 to 200 words once or twice so that his voice could be recognised later. It is already possible for the physically handicapped to use voice to control wheelchairs, operate equipment or give commands to personal computer operating systems.

Related R&D Work

Work on the development of surrogate keyboards like those in the MIKE [Watts,1985] and the MAVIS systems [Schofield, 1981] began more than ten years ago. The keyboard was replaced by a screen version. The scanning technique, described earlier, was employed and selection of the right key on the screen could be made with a single switch, two switches or even a 4-way joystick. Since then, the surrogate keyboard has been augmented in various ways. The latest term used is 'virtual keyboard'. Users are now able to select required words and phrases from the screen instead of just letters of the alphabet. The whole idea is to enhance the typing speed of the disabled users. Many severely physically disabled individuals also have delayed language development that makes spelling difficult. Whole-word access make the software more useful to them. Spelling checkers and correction software that identify and correct spelling errors automatically have also been developed. All these are tool that will help the disabled to produce text faster. A list of currently available products to enhance the typing speed of those with mild to moderate orthopaedic disabilities is presented in [Brown, 1993].

Researchers are now looking into ways to augment the virtual keyboard with more processing capabilities, that is making it more efficient and accessible. One major enhancement to the virtual keyboard is to make it more intelligent by having a word prediction capability. The user needs only to enter the first, second or third character and the rest of the word would be completed by the software. Such software uses artificial intelligence technique for prediction. Domain knowledge, knowledge of the rules of English language usage and knowledge of the user (his vocabulary, usage patterns and word preferences) are required by this type of knowledge-based application software. This type of software is already available in the market.

Another category of software employs coding techniques to generate words and phrases for the user. Abbreviation expansion systems allow the user to select words by entering the predefined abbreviations of the words. Since the abbreviations and their meanings have to be memorised, such systems do impose a heavy cognitive burden on their users. Semantic coding systems require the user to use a set of semantic primitives which could be icons. Each icon has a different meaning in a different context. The user will have to select sequences of two or three icons in order that the system can generate the words they want. This technique also requires the user to memorise a large number of sequences and their meanings but the use of icons as semantic primitives do make it easier.

Research in text generation is also in progress. In a technique known as sentence companion [Demasco, 1993], telegraphic and ungrammatical inputs are converted into a well-formed meaningful sentences. Systems making use of such techniques make text entry more efficient by shifting the physical burden from the disabled user to these assistive tool. It is apparent that such intelligent systems should have linguistic capabilities and very large knowledge bases in order to provide an acceptable level of performance.

Two closely related R&D areas, continuous speech recognition and natural language understanding will, hopefully, produce results that will also benefit the physically handicapped. The ultimate goal is to be able to talk to the computer and be understood; systems with this capability will be extremely useful to those who are physically handicapped with no speech or hearing impairments. Present voice input systems (including those that are speaker-independent) can only recognise discrete spoken words from a limited vocabulary. They are not able to

recognise continuous speech. "The difficulty revolves around recognising the boundaries between spoken words. Normal speech patterns slur the boundaries [Schneiderman, 1992]." Recognition, however, does not imply understanding. To understand spoken language, all the knowledge for the understanding of written text is required in additional to the knowledge about phonology and ambiguities in speech [Rich, 1983]. The minimum linguistic capabilities and 'habitability' features [Wallace, 1984] of Natural Language Interface systems are highlighted in [Chan, 1987].

Conclusion

This paper focuses on the physically disabled and the technologies available to enable them to access computers. To help the physically disabled to use the computer, it is important not only to know their disabilities but also their abilities. There is no one solution that is applicable to all and assessment of individual needs is therefore absolutely necessary. Special assistive technologies are also available for those who are blind or have poor vision, and those who are deaf or hearing impaired. Most hardware and software have been, and will continue to be designed for use by people with no disabilities. Research and design work in the area of assistive computer technology for the disabled are considered by many as non cost-effective and 'unglamorous'. Too little R&D work have been carried out and not surprisingly, very little is publicized of what have already been done. The UN has estimated that 10% of the population are disabled. Another interesting observation by some people is that "we are all disabled, it is just a matter of degree" [Glinert, 1992]. If this is the cast, then perhaps more can be done to allow the disabled to have easy access to computers for recreation, education, vocational training and employment purposes. With further advances in IT, it is likely that more access solutions will surface in the future.

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