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Talking to the Ceiling: An Interface for Bed-Ridden Manually Impaired Users

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ABSTRACT

Even though computer interfaces for handicapped and elderly people have already been investigated for quite some time, little attention has been paid to the special access problems of bed-ridden people. In this video and paper, we present a human-computer interface that enables a person who is almost completely paralyzed and on an artificial respirator to write literary texts on his own again. Many of the observations give clues for the design of interfaces for bed-ridden manually impaired users in general.

Keywords

Assistive Technology, Gerontechnology, Speech Recognition, Ubiquitous User Interfaces, User Interface Adaptation

INTRODUCTION

In Germany alone, about 6.5 million people are severely handicapped. As the likelihood of physical impairment increases with age, the rising average age of the population implies a significant growth of the number of handicapped people in the future. Information technology can often assist elderly and handicapped people to live the way they choose and to share in the social, cultural and economic activities of their communities, in spite of physical handicaps. The increasing power of information technology can especially be exploited to create new human-computer interfaces that in many cases can compensate even severe impairments.

Computer interfaces for handicapped and elderly people have already been investigated for quite some while. However, little attention has been paid to the special computer access problems of bed-ridden people. One reason for this omission may be that the residual cognitive abilities of people who are completely bed-ridden often are insufficient to allow them to use computers. In other cases, confinement to a bed may only be a temporary condition (e.g. after an accident) and there may be little need for computer access during this time. However, this is by no means the rule. For instance, about 8,000 people in Germany suffer from 'Amyothroph Lateral Sclerosis' (ALS), an incurable disease of the nervous system that leads to progressive muscular atrophy. (A prominent victim of this disease is astrophysicist Stephen Hawking.)

OUR SYSTEM AND ITS USAGE SITUATION

Our patient learned five years ago that he had ALS. Today his legs, hands, chest and diaphragm are paralyzed, and he uses an artificial respirator. Our patient had been a writer and an editor for the arts in a major German newspaper. Two and a half years ago he had lost the ability to type or write, due to his disease. To be able to write letters and literary texts again had become his major desire.

In the TEDIS project [1], we employed current developments in information technology to enable our patient to use a word processor on a PC. Speech was an obvious starting point for the user's input into the system. However, it was impossible to simply use a system off the shelf. Several major modifications had to be performed to cater to the specific usage environment, particularly the existence of a respiratory device (these adaptations will be described below). Speech recognition systems typically have to be trained on a specific user. With our patient, the basic training took about two weeks until the recognition results were satisfactory.

A person who is forced to permanently lie on his back cannot use a conventional monitor. This is prohibited by a combination of weight and resulting fixture problems, the need of easy access to the patient (which must even be immediate in emergency situations), and safety considerations and associated problems with liability and insurance. Therefore our patient's computer is hooked to a video beamer that projects the screen image against the white ceiling of the room. For our patient, working with his computer literally means talking to the ceiling.

RESULTS

Our system has been used for a period of about seven months so far, primarily for writing poetry, entries in a diary, and letters. The frequency of use varied between 5 and 15 hours per week. Several observations have already been made, some of which are specific to our special case while others coincide with current knowledge about the introduction of computers to elderly and handicapped users.

Need for a permanent computer-savvy tutor/companion

Our patient had minimal prior computer exposure and it was not possible to leave him completely unattended with the system for an extended period of time. First, the speech recognition system needed considerable additional training over a period of several weeks after the two-week basic training. Moreover, since the Windows operating system was fully accessible to him due to the fact that he needed to be given access to file management, our patient initially also tended to get “stuck” in branches that he had inadvertently entered. Fortunately he had a computer-savvy friend who was willing to spend numerous hours in the speech-training phase and to come in on demand when our patient needed help.

This experience is matched by similar findings in computer usage by elderly and handicapped people (e.g. for communication, alert-giving, and route planning) where telephone hotlines proved insufficient in many cases to guarantee the usage of the deployed computer systems over an extended period of time. Personal visits by trained tutors were usually found to be indispensable.

Projected video image seems to be acceptable

Our patient did not report any vision problems when interacting with the video image (which was projected in VGA resolution with 600 Lumen on a white ceiling and had a size of about 6x4 feet). However, the subject usually did not work for more than two hours in a row since he easily became fatigued as a result of his medical condition. It is therefore premature to make general claims about the long-term acceptability of this kind of interface.

Verbal commands too long

It turned out that our patient had a hard time pronouncing commands for text manipulation whose names were longer than three syllables since the respiratory cycle of the breathing device simply did not give him enough time. The names of these commands therefore had to be shortened.

Filtering the background noise of the respiratory device

Since the mouth piece of the respiratory device was very close to the microphone, its hissing noise would have normally disturbed the reliability of the speech recognition program. Filtering this white noise however turned out to be fairly easy with DragonDictate. In order not to overburden the patient, the initial filtering parameters were determined by simulating the noise of the respiratory device with an air pump.

No desire for communication through computer

Our patient did not accept our offer to also connect him to the Internet and thereby enable him to communicate remotely through email, and at a later stage possibly through Internet telephony. He claims to be completely satisfied using the computer as a typewriter and a document storage only. This finding is paralleled by experiences when introducing communication technology to elderly people with no prior exposure to this technology. Person-to-person contacts, even if they only occur rarely, are often preferred in such cases.

Good overall satisfaction

Our patient reported good overall satisfaction, particularly when compared to his previous situation where he had to dictate his works to a human scribe. He also exhibited the “normal” degree of frustration of PC users concerning the reliability and controllability of the computer and the speech recognition software.

DISCUSSION AND CONCLUSION

The current prevalent opinion in the construction of user interfaces for the elderly and the handicapped is that it is not advisable to first build computer systems for “normal” users, and only afterwards make them accessible to users with special needs. This is both technically and economically unsatisfactory and also results in computer systems for users with special needs trailing behind those for normal users. Instead, generic user interfaces should be developed that can be adapted to the needs of all users, including the handicapped and the elderly (“User Interfaces for All” – cf. Stephanidis 1998). While we fully endorse this approach in general, our case however shows its limits in situations where the tailoring to a specific user must be primarily performed on the hardware level and includes the complete physical environment.

Our system demonstrates a possible solution for enabling bed-ridden manually impaired people to interact with computers. Such a system can compensate some physical impairments of such individuals (particularly their manual impairment) and provide opportunities for extending their independence by enabling textual and audio-based recordings, communication, and environmental control (only textual recordings and letter-based communication were requested in our situation). Other technical alternatives may become feasible if flat-screen displays (particularly plasma-based ones) continue to drop in price. Through these computer-based “protheses”, bed-ridden manually impaired individuals will be able to continue their habitual lifestyle for a longer period of time, see more meaning in their lives (as was the case for our patient), and possibly remain cognitively active for longer.

However, the installation, maintenance and training costs for such systems are enormous (roughly, they exceed the hardware costs by a factor of 10). It remains to be seen whether and to what extent insurers (like the German national health or disability care-taking insurance agencies who have to cover devices that allow for more independent living) will be willing to finance such installations.

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Video available at http://ibserv.gmd.de/tedis_dl/tedis_hi.rm