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Using qualitative research methods to inform user centred design of an innovative Assistive Technology device

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The SPECS project aims to develop a speech-driven device that will allow the home environment to be controlled (for example turning on or off the lights or television). The device developed will be targeted at older people and people with disabilities and will be sensitive to disordered speech. Current environmental control systems (ECS) work using either a switch interface or speech recognition software that does not comprehend disordered speech well. Switch-interface systems are often slow and complicated to use and the uptake of the available speech recognition system has been poor [18].

A significant proportion of people requiring electronic assistive technology (EAT) have dysarthria, a motor speech disorder, associated with their physical disability. Speech control of EAT is seen as desirable for such people but machine recognition of dysarthric speech is a difficult problem due to the variability of their articulatory output [1]. Other work on large vocabulary adaptive speech recognition systems [2-6] and speaker dependent recognisers [3, 11-13] has not provided a solution for severely dysarthric speech. Building on the work of the STARDUST project [14] our goal is to develop and implement speech recognition as a viable control interface for people with severe physical disability and severe dysarthria. The SPECS project is funded by the Health Technology Devices Programme of the Department of Health.

Design methodology & User Involvement

User input was viewed as central to the design of the new device, and the design process drew heavily on the RESPECT [15] and USERFIT [16] user-centred design frameworks. The initial research aimed to specify the requirements of speech enabled environmental control systems (ECS) and to feed this into the design process of the new device. Two main methods were used for the initial stages of the user requirements gathering process – interviews and focus groups.

Users of existing speech enabled ECS were interviewed about their experiences of using these existing systems. Users were recruited from around the country through EAT providers in NHS services. Twelve existing users were recruited – the number was determined by saturation of the data, the small cohort of device users and the bureaucratic requirements of research governance applications within the NHS. Interviews were carried out by researchers experienced in Assistive Technology and were designed to be open and free ranging whilst also drawing on a pre-defined topic guide.

A focus group was also held with professionals involved in providing environmental control systems who had experience with speech input devices. This enabled the perspective of the providers to be examined and any barriers to provision highlighted. In addition the professionals were able to draw on a wide range of experience of provision of these and similar devices to our user group.

Data Analysis & Application

Framework analysis [17], a qualitative research tool, was chosen as the basis for interpretation of user data since it allows a very focused analysis that can be orientated specifically towards the needs of the development. The framework was developed using preliminary data from the first two interviews and further interviews were subsequently analysed according to this framework. The outcome of the framework analysis process is a rigorous, in-depth investigation of the themes relating to the use of such devices. Each theme was illustrated by representative extracts from the data, as shown in the example below:

Reliability – *[Link to full Data]*

Unreliability, the most heavily referenced perceived reason for failure, was seen as a key issue by many participants. One of the main problems of reliability was identified as the sound interference (see separate sub-theme) and included misinterpretation of commands. Most participants had an overall feeling that the device was not reliable. Participants identified a range of frequencies of unreliability, but most experienced problems daily:

> “Yesterday was my aunt’s birthday up the road so my dad had to nip up there and that left me with a screaming cat, a howling dog, a television going in all directions, lights going on, phones flashing and it was just ‘get this bloody thing out of here!’. It was driving me mad in the end. “

> “normally it doesn’t let me down but it did on that occasion when I really needed it, that’s the trouble, when I really needed it.”

“how often would you say it misses a command or gets a command wrong?

Maybe one in five, one in six. As I say, it depends on circumstances. If the television is noisy then it’s more often, it can be one in two. If you’re on your own and the thing is quiet, maybe one in ten or less.”

“Literally it drives me insane. It doesn’t respond to his voice all the time and you have to repeat and repeat and repeat and I say ‘switch it off, I’ll go and get the handset and do it from the handset’.

But it defeats the whole point of me having it.”

The data from the user involvement feeds into both the hardware and software design - for each theme design features were identified and used to influence the relevant specifications. Data on reliability, for example, allowed us to specify targets for recognition accuracy.

The software specification has two components – the recognition engine and the user-interface. Work on the previous STARDUST project effectively specified the recognition engine, but refinements have been introduced as a result of qualitative data. To specify the user interface, initially some simple case scenarios based on participant’s data were produced. The results from the framework analysis were subsequently used to produce a comprehensive user-orientated specification and allowed the software designer to fully appreciate the pertinent issues for users.

Having developed an initial working prototype, iterative testing will be carried out with a typical cohort of end users. This may take a number of forms, including testing with prototype devices, software simulations and ‘wizard-of-oz’ style simulations. In addition, professionals will be consulted through workshops at a UK conference with possibly a further focus group to review the prototype device. Further prototypes will allow for information from the user testing to be incorporated into the device before it is released onto the market.

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References

1. Blaney B, Wilson J. Acoustic variability in dysarthria and computer speech recognition, Clinical Linguistics and Phonetics, 2000, 14(4), 307-327
2. Hawley MS Speech Recognition as an Input to Electronic Assistive Technology, British Journal of Occupational Therapy, 2002, 65(1), 15-20
3. Rosengren E, Raghavendra P, Hunnicut S How does automatic speech recognition handle severely dysarthric speech? Proc 2nd TIDE Congress, Paris, April 1995
4. Thomas-Stonell N, Kotler A-L, Leeper HA, Doyle C Computerized speech recognition: influence of intelligibility and perceptual consistency on recognition accuracy, Journal of Augmentative and Alternative Communication, 1998, 14, 51-55
5. Ferrier LJ. Shane HC. Ballard HF. Carpenter T. Benoit A. Dysarthric Speakers' Intelligibility and Speech Characteristics in Relation to Computer Speech Recognition. Journal of Augmentative and Alternative Communication, 1995, 11, 165-174
6. Kotler, A., Thomas-Stonell, N Effects of speech training on the accuracy of speech recognition for an individual with a speech impairment, Journal of Augmentative and Alternative Communication, 1997, 12: 71-80.
7. Deller Jr JR. Hsu D. Ferrier LJ On the use of hidden Markov modelling for recognition of Dysarthric speech. Computer Methods & Programs in Biomedicine, 1991, 35(2), 125-139.
8. Clark JA, Roemer RB Voice controlled wheelchair. Archives of Physical Medicine & Rehabilitation, 1977, 58(4), 169-75
9. Cohen A, Graupe D Speech recognition and control system for the severely disabled. Journal of Biomedical Engineering, 1980, 2(2), 97-107
10. Rosen, K., Yampolsky, S Automatic Speech Recognition and a Review of Its Functioning with Dysarthric Speech, Journal of Augmentative and Alternative Communication, 2000, 16: 48-60
11. Polur PD, Miller GE, Effect of high-frequency spectral components in computer recognitionof dysarthric speech based on a Mel-cepstral stochastic model, Journal of Rehabilitation Research and Development, 2005, 42, 3, 363-372
12. Polur PD, Miller GE, Experiments With Fast Fourier Transform, Linear Predictive and Cepstral Coefficients in Dysarthric Speech Recognition Algorithms Using Hidden Markov Model, IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2005, 13, 4, 558-561
13. Polur PD, Miller GE, Investigation of an HMM/ANN hybrid structure in pattern recognitionapplication using cepstral analysis of dysarthric (distorted) speech signals, Medical Engineering & Physics, forthcoming
14. Hawley MS, Enderby P, Green P, et al, (2003) "STARDUST; Speech Training And Recognition for Dysarthric Users of Assistive Technology." In Assistive Technology – Shaping the Future, eds: GM Craddock et al, IOS Press, pp 959-64.
15. Maguire M, Kirakowski J., Vereker N, RESPECT: User centred requirements handbook, Telematics Applications Programme, 1998
16. Userfit: a practical handbook on user-centred design for assistive technology, Poulson D, Ashby M Richardson S (Eds) – TIDE European Commission (see http://www.stakes.fi/include/1-4.htm)
17. Ritchie J, Lewis J, Qualitative Research Practice: A guide for Social Science Students and Researchers, Sage Publications Inc, 2003
18. C Geggie, Voice Control of Environmental Control Systems., ACNR, Vol 3, Issue 4, 2003.