Voice Control of Environmental Control Systems

Lothian’s Electronic Assistive Technology provides environmental control equipment to enable people with special needs to control electrical/electronic equipment within their homes.

At present there are 57 such installations of environmental control equipment within the Lothian region. Most of the equipment fitted uses a scanning method for the selection of options from a display panel. Voice control is also an option and at present there are five installations of voice based environmental control equipment in Lothian, the first of which took place four years ago.

Voice recognition has been available as a method of computer control for a number of years. There are two main producers, IBM and Dragon Systems. Both require a head worn microphone and a microcomputer and have the advantage of adapting to changes in the user’s voice. It is possible to use this software for environmental control by fitting an infrared transmitter to a microcomputer or wheelchair mounted laptop computer. However the former would contrast with the trend within environmental control towards portable compact equipment and the latter would result in reduced reliability because the laptop computer, due to its hard drive, is more prone to damage caused by vibration than a dedicated environmental control unit.

Our experience with voice based systems has been with the Sicare Pilot (figure 1). The Pilot is a compact voice operated unit that can be clamped to the user’s wheelchair or positioned on an overbed table. Two models are available, one that transmits infrared only and another that transmits radio signals as well. The Pilot includes a built in microcomputer and a built in speaker enunciates the command just recognised. The Pilot can be operated with one or two switches, as a backup method to voice control.

The Pilot utilises a menu tree structure of commands (see figure 2). This tree structure is constructed during installation with commands being classified into branches associated with different devices e.g. TV, telephone, intercom etc. Infrared signals are then assigned to each command by either selecting from a database of infrared signals or training the Pilot with infrared signals from the user’s remote controls. Voice profiles are then linked to each command by training the Pilot with the user’s voice.

The tree structure is necessary to maximise recognition reliability so at any stage in its use the Pilot is looking for the user to utter one of a few commands in the active branch of the menu, and not looking for the full vocabulary. The Pilot can store a maximum of 64 voice profiles but the tree structure makes it possible to reuse particular voice profiles within different contexts. For example the numbers 0, 1, 2, 3 can be used both within the telephone and TV branches of the menu making the Pilot’s memory the limitation on the maximum number of commands. The manufacturer states that they have configured a Pilot with 410 commands and noted that less than 50% of available memory was used.

Fixed display scanning environmental control units such as the Steeper Fox and Gewa Prog have a maximum number of commands of 62 and 161 respectively. This is less than the Pilot but sufficient for most users. Alternatively the SRS 100, a scanning environmental control unit with a LCD screen could be considered. This device, because of its dynamic display, has a maximum number of commands limited only by its memory. The manufacturer states that the SRS 100’s maximum number of commands is 2500.

Criteria for selecting voice control

1) Users must have a reliable repeatable voice.
2) Users must have a sufficiently good memory to memorise the Pilot’s menu tree structure.
3) The user’s level of disability should probably exclude other simpler options. The Pilot is approximately 2.5 times the cost of the Gewa Prog or Steeper Fox so initial and replacement costs will be significantly greater.
4) Also, a number of follow up visits may be required, in the weeks immediately after installation, to retrain problem voice profiles. These follow up visits obviously represent a cost in terms of staff hours.
5) It’s helpful if the user has a good motivation to work with technology. One reason is to fully exploit the functionality offered by the Pilot but also a high level

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Relaxants. Polymyxins, tetracyclines, lincomycin and muscle aminoglycoside antibiotics or other drugs that interfere with the risk of dysphagia. 

Inject 1-2 cm apart. Preferential cooled poly I. Injecting 25-34 U needs the medial and lateral heads of the affected gynaecomastia muscle. Recommended total dose: 10 U. Injectable dose between 30-40 U are equal to or more resistant to fibrosis. Multiple injection sites may facilitate more uniform contact with the innervation areas of the muscle, especially in larger muscles. Tailor dose and number of sites based on size, number and location of muscles involved, the severity of spasticity, and the presence of local muscle weakness. 

Continuous I.: Known hypersensitivity to any constituent. Generalised disorders of muscle activity (e.g. myasthenia gravis). Contraindicated use with underlying pulmonary or cerebral disorder. Preexisting respiratory symptoms. 

Hyperhidrosis of the axillae: Do not inject sternocleidomastoid muscle bilaterally. Inject using a 27-30 gauge needle (for superficial muscles) or a longer needle for deeper muscles. Multiple injection sites may facilitate more uniform contact with the innervation areas of the muscle, especially in larger muscles. Tailor dose and number of sites based on size, number and location of muscles involved, the severity of spasticity, and the presence of local muscle weakness. 

Cervical Dystonia: Limiting dose into the orbicularis muscle can lead to corneal, symmetrical effect and corneal ulceration, especially in patients with keratoconjunctivitis. Avoid contact of corneal sensation in eyes previously operated upon, especially in patients with VIIth nerve disorders. Careful testing in the event of a problem e.g. the user requiring a ventilator, then backup switches are required. If there are factors that increase the risk of dysphagia then, similarly, it would be wise to consider backup switches. We would also have serious concerns about voice control training to be done within a fixed time slot. 

Factors to Maximise Reliability

1) During training make the five passes through the list command with different levels of background noise.

2) Use the small clip-on microphone to make the Pilot less susceptible to background noise. Note the position and orientation of the microphone during voice training and ensure that the user has this information so carers can set the microphone up similarly each day.

3) Maximise the phonetic difference between commands. For example use “Dial Out” instead of “Dial” in order to include more syllables.

4) Structure the menu tree to minimise the number of commands within each branch. This is especially important for more safety-critical commands.

Reliability for Safety-Critical Functions

There is some concern about using voice control for safety-critical commands e.g. to call for help via alarms. Our experience with the Pilot leads us to conclude that occasionally the user may have to repeat commands. This is especially the case when significant background noise is present, e.g. when the hi-fi is playing when it may be difficult for the user to wait for a lull in the sound before proceeding. 

The risks have to be weighed up in each case in order to establish if backup switches are required. If there are factors that increase the risk in the event of a problem e.g. the user requiring a ventilator, then backup switches should be provided. For community alarms where assistance is being sought from a carer outwith the immediate home environment then, similarly, it would be wise to consider backup switches. We would also have serious concerns about voice control being used for the control of electrically tilting armchairs where there is a risk of injury to the user.

Acknowledgement

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