Speech Technology for E-Inclusion and Rehabilitation

Mark Hawley
Focus on:

- physical disability
- dysarthria

• Access
• Control
• Communication
• Assessment
• Treatment
Access

• Speech recognition provides important means of access for some people with physical disability and ‘normal’ speech

• Recognition accuracy correlates with intelligibility
  – Speech recognition works for ‘normal’ speech, mild dysarthria and some moderate dysarthria
  – Does not work well for severe dysarthria

• Speaker dependent discrete word recognisers more successful than continuous for severe dysarthria
Control

- Control of the home environment an essential aspect of independence

- Current control methods can be slow and effortful

- Home control systems based on speaker dependent recognition are available
  - but do not perform adequately, especially for disordered speech
STARDUST
(Speech Training and Recognition for Dysarthric Users of Assistive Technology)

• User-centred approach – aim to make it work for our users
  – Speaker dependent recognition
  – Small vocabulary of discrete words tailored to speech capabilities of individual
  – Closed loop between recogniser training and user training
Initial training data

Additional training data

Recogniser training

User training

Final recogniser models
Switch

Microphone

Recogniser

Score calculation

PC

Stimulus: lamp

Short press to start recording
Long press to move onto next word
Double press to play best-fit recording
<table>
<thead>
<tr>
<th>Participant</th>
<th>Vocabulary size</th>
<th>Pre-training</th>
<th>Post-training</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of examples of each word</td>
<td>recognition accuracy (%)</td>
<td>No. of examples of each word</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>30</td>
<td>95.8</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>13</td>
<td>96.2</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>30</td>
<td>82.0</td>
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<td>13</td>
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STARDUST recognition accuracy

<table>
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<tr>
<th></th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Intelligibility Rate (%)</th>
<th>Recognition Accuracy (%)</th>
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<td></td>
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<td></td>
<td></td>
<td>Word (test)</td>
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<tr>
<td>1</td>
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<td>Cerebral Palsy (CP)</td>
<td>10</td>
<td>100.0</td>
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<td>2</td>
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<td>Multiple Sclerosis</td>
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<td>100.0</td>
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<tr>
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<td>M</td>
<td>CP</td>
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<tr>
<td>4</td>
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<td>CP</td>
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<td>99.7</td>
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<td>5</td>
<td>F</td>
<td>CP</td>
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<td>90.8</td>
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</table>

Recognition accuracy in the home in normal usage under uncontrolled conditions
Communication

• Speech synthesis used extensively in assisted communication

• Much current research aims to increase the ‘naturalness’ of synthesised speech
  – Naturalness vs. intelligibility
  – Complex issues regarding acceptance of ‘natural’ voices by disabled people
VIVOCA
Voice-input voice-output communication aid

Microphone → Speech Recogniser → ‘translation’ algorithm → Speech synthesiser or recording → Speaker
User and professional consultation

Method
VOCA users and speech therapists
Semi-structured interviews and focus groups
Thematic analysis

Results

- Acceptable as a means of communication
- Potential advantages over conventional VOCA
  - Quicker
  - Easier to use
  - Increased communication and independence
- Useful where speed and intelligibility crucial
  - Meeting new people
  - Telephone
  - Shopping
- Range of requirements for hardware and software
Assessment

Normal voice quality, low pitch variation (PVI=1.03)

Hoarse / strangled voice, pitch variation is greater (PVI=2.73); CFDA objective measurement computes a ‘D’ grade
Therapy

Mean log-likelihood vs Number of observations for subjects 1 to 7.
A clinical trial (7 subjects) suggests:

- Computerised therapy can be as effective as traditional techniques
- Patients can practise independently
- Potential for intensive treatment with reduced routine therapist input

OLP (Ortho-Logo-Paedica)
Tele-therapy
Summary

• Speech technology has an important role in assistive technology:
  – Access
  – Control
  – Communication
• And in therapy:
  – Assessment
  – Treatment
• R&D in clinical applications of speech technology is multi-disciplinary
  – requires knowledge of disabled user, assistive technology, speech pathology and speech technology
• Role of speech technology for older people?