Feasibility of technology enabled speech disorder screening

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Speech pathology assessment

- 20% of 4 year olds have some sort speech & language problem

- Long waiting lists for assessment:
  - 25% waiting > 6 months,
  - 15% > 1 year

- After assessment
  - 18% wait > 1 year for treatment

- Greater shortage in rural and regional areas

- Social inequalities

Speech pathology assessment

- If left undiagnosed or untreated
  - poorer literacy and academic outcomes
  - reduced employment prospects
  - increased likelihood of
    - social
    - emotional and
    - mental health issues

Speech pathology assessment

- Solution
  - mobile screening tool
  - broad & early screening
  - GPs, nurses, parents, teachers,...

- Investigate feasibility of automated speech assessment

- Develop early prototype

http://www.ahcpofva.com/mobile-health/
Automatic Speech Recognition

• Most applications for treatment

• Challenges
  • Phoneme Level Analysis
  • Child Speech
  • Disordered Speech

Types of Speech Errors
The Four Main Classes

- **Substitutions**
  - Phoneme - Correct
  - Placement - Incorrect

- **Additions**
  - Phoneme - Correct
  - Placement - Incorrect

- **Distortions**
  - Phoneme - Incorrect
  - Placement - Incorrect/Correct

- **Omissions**
  - Phoneme - N/A
  - Placement - N/A
Common Substitution Errors

- /th/
  - as in three
- /f/
  - as in frogs

• Substitution of /f/ for /th/

- /r/
  - as in green
- /w/
  - as in witch

• Substitution of /w/ for /r/
Our approach

Input Speech → Phoneme Classification → Knowledge Driven Recognition → Decision Support

Data

- 150 Unique Children Speakers

- Age: 3-14 years

“Fish Teeth Rain Feather Scissors Three
Van Watch Boy Girl Pig “

Training:
- 11 words
- 29 phonemes
- 8 minutes
Phoneme Classification

• Recognition of phonetic subunits in a word

Teeth:

T / IY / TH
Phoneme Classification

“three”

/th/  /f/  /r/  /w/  /i/
Phoneme Recognition Results

Accuracy = 69%

Neural Networks
Knowledge Driven Recognition
Using Knowledge of Target Word & Forced alignment

Needleman-Wunsch Algorithm
# Feasibility - Accuracy

For Correct and Mispronounced Phonemes

<table>
<thead>
<tr>
<th>Target</th>
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<th>Mispronounced</th>
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## Feasibility - Accuracy

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### Specific error classified: 60.6%

### Unspecific error: 39.4%
Demonstration application for speech disorder screening technology.

**Speech APP**
- **Age**
- **Gender**: Male, Female
- **Mode**: Amateur, Pro
- **Begin**

**Example Tasks**
- **The Girl is Standing in the...**
- **You Chew Food Using Your...**

**Therapist Notes**
- **Boy**: N/A
- **Fish**: /sh/ /ih/ /sh/
- **Girl**: /g/ /er/ /w/
- **Rain**: /w/ /ey/ /n/
- **Scissors**: /sd/ /ih/ /z/ /ea
- **Teeth**: /f/ /th/ /f/

*Note: N/A - Audio Could Not Be Analysed. Confidence level high.*
Next steps

• Develop business case
• Develop mobile prototype
• Integrate expert knowledge & develop decision support system
• Collect more data
• Refine models and algorithms
• Develop and deploy screening tool