Aligning tongues and palates with Palatron

Jeff Mielke, Adam Baker, Diana Archangeli, Peter Richtsmeier, and Sumayya Racy

University of Arizona

Supported by College of Social and Behavioral Sciences, University of Arizona, and James S. McDonnell Foundation grant #220020045 BBMB
Goals

- Add fixed point of reference to ultrasound images.
- Add palate image to ultrasound images of the tongue.
- Avoid compromising portability and relative affordability of ultrasound.
Overview

- Use video camera to track head and transducer movements.
- Use yogurt to create palate images.
- Implement an algorithm to correct for movements.
- Align images
  - tongues and palates
  - sequences
Two images
Two ultrasound images
Combining two ultrasound images
Track head movement
Track transducer movement
Blue screen
Subject
Input
Get video and ultrasound scales
Get head and transducer angles
Compensate for angles
Transducer location/orientation
Head location/orientation
Image with palate
Palatron

- Implemented as a Java plugin for *ImageJ* (Wayne Rasband, NIH)
Experiment methods

- Subjects produce monosyllabic words with velar and alveolar stops and various vowels.
- Add palates to images by simply overlaying adjusted images and by transforming and overlaying with Palatron.
- Measure distance between tongue and palate in each case.
Average tongue-palate distance

- **Subject 6:**
  - unadjusted: 4.57 mm  \( p < 0.001 \) (T-test)
  - Palatron: 3.67 mm

- **Subject 8:**
  - unadjusted: 5.60 mm  \( p < 0.001 \) (T-test)
  - Palatron: 3.05 mm

- **Subject 9:**
  - unadjusted: 5.04 mm  \( p < 0.001 \) (T-test)
  - Palatron: 2.32 mm
Average constriction location
(0 = most anterior, 1 = most posterior)

<table>
<thead>
<tr>
<th>Subject 6: alveolars</th>
<th>velars</th>
<th>diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>unadjusted: .03</td>
<td>.10</td>
<td>.07</td>
</tr>
<tr>
<td>Palatron: .13</td>
<td>.83</td>
<td>.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject 8: alveolars</th>
<th>velars</th>
<th>diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>unadjusted: .27</td>
<td>.74</td>
<td>.47</td>
</tr>
<tr>
<td>Palatron: .17</td>
<td>.75</td>
<td>.58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject 9: alveolars</th>
<th>velars</th>
<th>diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>unadjusted: .07</td>
<td>.40</td>
<td>.33</td>
</tr>
<tr>
<td>Palatron: .12</td>
<td>.66</td>
<td>.54</td>
</tr>
</tbody>
</table>
No adjustment: velar stops
Palatron: velar stops
No adjustment: alveolar stops
Palatron: alveolar stops
Series: stationary palate
Conclusions

- Palatron compensates for head and transducer movements.
- Saves considerable time over hand-correction.
- Doesn't require much extra equipment.
Future directions

- Implement a version of Palatron that adds palates on the fly and displays them in real time.

- Consistently get (and interpret) location of incisors from video view.

- Figure out how to deal with velum movement.
Series: stationary fan