Super-Resolution Classification Improves Facial Nerve Segmentation from CBCT Imaging

Ping Lu¹, Livia Barazzetti¹, Vimal Chandran¹, Kate Gavaghan², Stefan Weber³, Nicolas Gerber³, Mauricio Reyes³

¹Institute for Surgical Technology and Biomechanics, University of Bern, Bern, Switzerland
²ARTORG Center for Biomedical Engineering Research, University of Bern, Bern, Switzerland

Motivation

- Cochlear implantation (CI) is a treatment for patient suffering from severe to profound hearing loss.
- A surgical planning software, OtoPlan, has been developed at the University of Bern for minimally invasive drilling of a cochlear access.
- One of the constraints of the surgical planning during trajectory definition is to avoid the facial nerve with sufficient safety margin.
- Cone-beam computed tomography (CBCT) is used for surgical planning, however, its relatively low resolution renders the identification of the nerve difficult.
- In this work, we hypothesize that supervised-learning techniques can be used to segment the facial nerve from CBCT for more precise surgical planning.

Preliminary Results

Quantitative comparison between the proposed super-resolution segmentation method and other segmentation software — Geos (version 2.3.6), ITK-SNAP (version 3.6.0) and OtoPlan.

<table>
<thead>
<tr>
<th></th>
<th>Our method</th>
<th>Geos</th>
<th>ITK-SNAP</th>
<th>OtoPlan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dice</td>
<td>0.939 ± 0.009</td>
<td>0.929</td>
<td>0.895 ± 0.006</td>
<td>0.927 ± 0.002</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.184 ± 0.011</td>
<td>0.195</td>
<td>0.184 ± 0.020</td>
<td>0.184 ± 0.016</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.931 ± 0.009</td>
<td>0.920</td>
<td>0.919 ± 0.020</td>
<td>0.927 ± 0.020</td>
</tr>
</tbody>
</table>

Example results for the proposed super-resolution segmentation approach. From left to right: Original CBCT image with highlighted (in blue) facial nerve, resulting segmentation and ground-truth delineation (orange contour), and zoomed area describing SRC results on four corresponding CBCT vowels.

The facial nerve segmentation comparison on the original CBCT image between the proposed SRC method and other segmentation software — ITK-SNAP, Geos and OtoPlan.

Conclusion. The proposed SRC approach yields highly accurate (sub-voxel) facial nerve segmentations, while being more robust than other methods.

Ping Lu
University of Bern Institute for Surgical Technology & Biomechanics
Stauffacherstr. 78 CH-3014 Bern
www.istb.unibe.ch
ping.lu@istb.unibe.ch