AUTOMATIC SEGMENTATION OF LARYNGEAL CARTILAGES USING SUPPORT VECTOR MACHINES

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Introduction

The presence and extent of cartilage invasion by laryngeal carcinoma is difficult to assess on routine MR imaging studies. The ultimate goal of this work is to apply image segmentation to assess the extent of laryngeal cartilage invasion by tumor. While fully-automated segmentation of the laryngeal cartilages remains unexplored, a multi-contrast and multi-dimensional approach has proven useful for segmenting articicular cartilage [1]. This approach is hindered by a lack of automatic intensity correction to compensate for the coil sensitivity profile when a dedicated array is used.

We propose a custom intensity correction algorithm, and we explore the use of supervised and unsupervised learning algorithms to automatically segment the cartilages from high-resolution larynx images of healthy volunteers. We compare the performance of two methods: (1) support vector machines (SVMs), a supervised learning algorithm that uses training data to build a classification model, and (2) k-means clustering, an unsupervised learning algorithm (requiring no training) that classifies input data by grouping datapoints with similar features into k clusters.

Methods

Scans were conducted on a 1.5 T GE Signa scanner using a larynx-dedicated three-channel array [2]. Four 2D multi-slice sequences were used on healthy volunteers, with the following scan parameters: FOV = 10 cm, BW = ±32 kHz, resolution = 0.78 x 0.39 mm², slice thickness = 2 mm, # averages = 2. Timing parameters specific to each sequence are listed in Table 1, and the resulting images from one slice of a larynx dataset are shown in Fig. 1.

Table 1. Imaging parameters

<table>
<thead>
<tr>
<th>Sequence</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>2000</td>
<td>20</td>
</tr>
<tr>
<td>SE</td>
<td>800</td>
<td>32</td>
</tr>
<tr>
<td>FSE-DEAL</td>
<td>3500</td>
<td>101</td>
</tr>
<tr>
<td>FSE-XL</td>
<td>800</td>
<td>8</td>
</tr>
</tbody>
</table>

Image segmentation via SVM:

- Training data manually segmented using 3DSlicer [4]
- LibSVM used for multi-class SVM [5]

Conclusions

We have successfully applied the SVM and k-means algorithms to segment the cartilages from MR images of the larynx. The implementation of an intensity correction technique significantly improved the performance of automatic segmentation. k-means clustering produced comparable segmentation results to SVM, with a slight improvement in overall accuracy and accuracy of cartilage classification. The main advantage of k-means over SVM classification is that it requires no manual segmentation of training data, which is tedious, time-consuming, and subject to error.

References