Trigger finger is a common hand disease, causing swelling, painful popping and clicking in moving the affected finger joint. To better evaluate patients with trigger finger, segmentation of flexor tendons from magnetic resonance (MR) images of finger joints, which can offer detailed structural information of tendons to clinicians, is essential.

In the proposed method, a set of tendon contour models (TCMs) is initialized from the most proximal cross-sectional image, and each of the TCMs is then propagated to its distally adjacent image. The TCMs on each cross-sectional image are finally refined with the snake deformation. And our method also showed good accuracy with small average margins of errors and large overlapping ratio. Overall, the proposed method has great potential for morphological change assessment of flexor tendons and pulley-tendon system modeling for image guided surgery.

Introduction

The proposed method includes two parts: tendon contour model initialization and tendon boundary segmentation.

Tendon Contour Model Initialization

Since the tendons in MR axial images are usually elliptic in shape, each tendon contour model (TCM) is initialized by estimating an ellipse from the most proximal image.

Tendon Boundary Segmentation

Model Shape Refinement via Snake Deformation

Iteratively updating the contour points by minimizing the following energy $E$:

$$E(M_i) = \sum_{j=1}^{N} (\alpha E_{edge} + \beta E_{region} + (1-\alpha-\beta)E_{shape})$$

Experimental Results

In the experiments, three MR volumes from different subjects with 16, 14, 13 cross-sections respectively were included. The proposed method could achieve satisfactory tendon segmentations with good fit and realistic shape, even in the presence of fuzzy boundaries and irrelevant tissues with similar intensity to tendons.

Table I. Accuracy evaluation result with ME, RMSE and DSC in (mean, standard deviation).

<table>
<thead>
<tr>
<th>Subject</th>
<th>ME (mm)</th>
<th>RMSE (mm)</th>
<th>DSC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (16)</td>
<td>(0.28, 0.05)</td>
<td>(0.43, 0.07)</td>
<td>(87.20, 1.56)</td>
</tr>
<tr>
<td>2 (14)</td>
<td>(0.29, 0.07)</td>
<td>(0.43, 0.11)</td>
<td>(86.94, 2.59)</td>
</tr>
<tr>
<td>3 (13)</td>
<td>(0.23, 0.10)</td>
<td>(0.35, 0.14)</td>
<td>(90.18, 4.15)</td>
</tr>
<tr>
<td>Average</td>
<td>(0.27, 0.07)</td>
<td>(0.40, 0.13)</td>
<td>(88.11, 2.77)</td>
</tr>
</tbody>
</table>

Conclusion

A novel model-based segmentation method is proposed. And our method utilized the structural constraint of the TCMs throughout the segmentation process, so reliable and accurate tendon segmentation can be achieved as demonstrated in the experimental results. In the future, the proposed method can be extended to segment the tendons of the whole hand for pulley-tendon system modeling. Also, this method can be used to measure geometric parameters of tendons (e.g., size) for evaluating the structural changes caused by trigger finger.