Group 21: Robotic Soft Tissue Manipulation Assessment

Seminar Presentation

"Quantitative Evaluation of Phonomicrosurgical Manipulations Using a Magnetic Motion Tracking System"

Chen et al. 2014

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Overview

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- Introduction
- Why I selected the paper
- Benefit of the study
- Experimental Design
- Parameters Developed
- Results
- Relevance to our study
Project Summary

• Assess and prove through subjective expert analysis that robotic assisted laryngeal surgery is more effective than mere manual surgery

• Use GALEN robot to assist in the laryngeal cyst removal surgery in animal larynx to mimic real surgery

Figure 1: Microlaryngeal Phonosurgery
Introduction

● Laryngeal diseases affect millions of people

● Vocal cords are extremely delicate as they define mucosal wave propagation and normal vibratory function in humans
  ○ Requires delicate and accurate surgical approach

● Traditionally surgeons are trained in an apprentice style where they observe and perform procedures under supervision

● Ability to objectively evaluate and provide feedback to surgeons would enhance consistency of surgical education

● Simulative training provides benefit for public health
Why I selected this paper

• Our analyses currently consist only of subjective parameters

• Very insightful look at how to objectively set up analyses parameters
  – Maintenance of motion smoothness
  – Minimization of Tremor
  – Compact and continuous spatial motion of the tip of an instrument
  – Coordination of two hands
Benefit of this study

• Using the objective metrics, simulation training systems could be put in place which would help surgeons in training develop better skills.
Experimental Design

-Magnetic Motion Tracking System called microBIRD

-Simulative Task included cutting out small squares using laryngeal microscissors
Parameters Developed

Motion Smoothness
\[ S = \frac{1}{T} \sqrt{\frac{1}{2} \int_0^T j^2 \, dt} \]

Path Length
\[ p = \sum_{0}^{T} \sqrt{(dx)^2 + (dy)^2 + (dz)^2} \]

Depth Perception
\[ D = |(x_1 - x_2) \cdot \cos(42^\circ) - (Z_1 - Z_2) \cdot \sin(42^\circ)| \]

Quality
\[ Q = \sum_{k=1}^{n} (A - A_k) / n \times A \]
## Results

### TABLE I. Comparison of Dominant-Hand Parameters.

<table>
<thead>
<tr>
<th></th>
<th>x-axis</th>
<th>y-axis</th>
<th>z-axis</th>
<th>P</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novices</td>
<td>0.294 ± 0.1870</td>
<td>0.366 ± 0.1918*</td>
<td>0.381 ± 0.2256</td>
<td>40.080 ± 22.4007</td>
<td>15.600 ± 9.1191</td>
</tr>
<tr>
<td>Experts</td>
<td>0.261 ± 0.1391</td>
<td>0.146 ± 0.0377*</td>
<td>0.373 ± 0.1628</td>
<td>38.020 ± 16.2938</td>
<td>13.490 ± 5.9172</td>
</tr>
</tbody>
</table>

*Statistically significant differences in a one-tailed t test ($P < .05$).

*D = depth perception; *P = path length; *S = smoothness.

### TABLE II. Comparisons of Nondominant-Hand Parameters.

<table>
<thead>
<tr>
<th></th>
<th>x-axis</th>
<th>y-axis</th>
<th>z-axis</th>
<th>P</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novices</td>
<td>0.188 ± 0.0870*</td>
<td>0.211 ± 0.0907*</td>
<td>0.220 ± 0.0952*</td>
<td>21.536 ± 6.8449*</td>
<td>9.109 ± 3.2757*</td>
</tr>
<tr>
<td>Experts</td>
<td>0.101 ± 0.0698*</td>
<td>0.116 ± 0.0596*</td>
<td>0.098 ± 0.0519*</td>
<td>14.747 ± 3.0808*</td>
<td>6.057 ± 1.5502*</td>
</tr>
</tbody>
</table>

*Statistically significant differences in a one-tailed t test ($P < .05$).

*D = depth perception; *P = path length; *S = smoothness.
Results
Results

➔ Found differences in kinematic parameters between experts (trained 5 trials) and novices (trained 4 trials)

➔ Experts had significantly better motion smoothness along the y-axis for the dominant hand and all 3 axes for non-dominant hand
Relevance to our study

• Team developed a novel approach to use magnetic fields to measure the movement of the tip of an instrument during a surgical procedure and provide quantitative feedback.

• Possible next step would be to actually do a simulated surgery on soft tissue (what we are trying to accomplish).

• If we could integrate an objective measure in our study, it would make our final deliverable much more crisp.


Questions