Reducing Cost and Complexity in Computer-Assisted Training for Breast Lumpectomy

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Introduction

• Breast lumpectomy is a common procedure often learned without any deliberate practice in a simulation laboratory
• We designed a training setup with objective technical skills assessment for lumpectomy [1] based on Perk Tutor (www.perktutor.org)

Objective

• We wish to reduce setup cost and complexity by removing sensors

Methods

Performance Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Completion time</td>
<td>Time required to complete all phases</td>
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<tr>
<td>Path length</td>
<td>Total distance travelled by the cautery, probe, left hand, right hand, and tumour</td>
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<tr>
<td>Rotational/translational actions</td>
<td>Number of rotational/translational actions of each hand, delineated by periods of rest</td>
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<tr>
<td>Tumour punctures</td>
<td>Number of times the cautery punctures the surface of the tumour</td>
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<tr>
<td>Tumour zones</td>
<td>Time the cautery tip is &lt;0mm, 0mm – 5mm, …, 25mm – 30mm, &gt;30mm away from the tumour during excision</td>
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Representative Metric Formulation

1. Determine which metrics distinguish novices from experts

2. Determine representatives for the factors underlying each metric

Validation

• Analyze 16 novice and 14 expert trials of simulated lumpectomy
• Compare accuracy of skill assessment via two methods using all metrics versus only representative metrics

Results

• The proposed metrics measure three aspects of technical skill

<table>
<thead>
<tr>
<th>Aspect of Technical Skill</th>
<th>Representative Metric</th>
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</thead>
<tbody>
<tr>
<td>Excision efficiency inside safety margin</td>
<td>Tumour zone: 0mm – 5mm</td>
</tr>
<tr>
<td>Palpation efficiency</td>
<td>Tumour path length</td>
</tr>
<tr>
<td>Excision efficiency outside safety margin</td>
<td>Tumour zone: 20mm – 25mm</td>
</tr>
</tbody>
</table>

Fig 1. Breast lumpectomy training setup.

Fig 2. Loading plots of metrics onto factors identified with domain knowledge.

Fig 3. ROC curves for overall proficiency assessment using the z-score (black) and SVM (red) methods with all (solid) or representative (dashed) metrics.

Conclusion

• Our results show that we can reduce cost and complexity in image-guided interventions training setups
• Hand sensors may be removed from the lumpectomy training setup; this does not compromise skill assessment quality

References & Acknowledgements


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