

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)

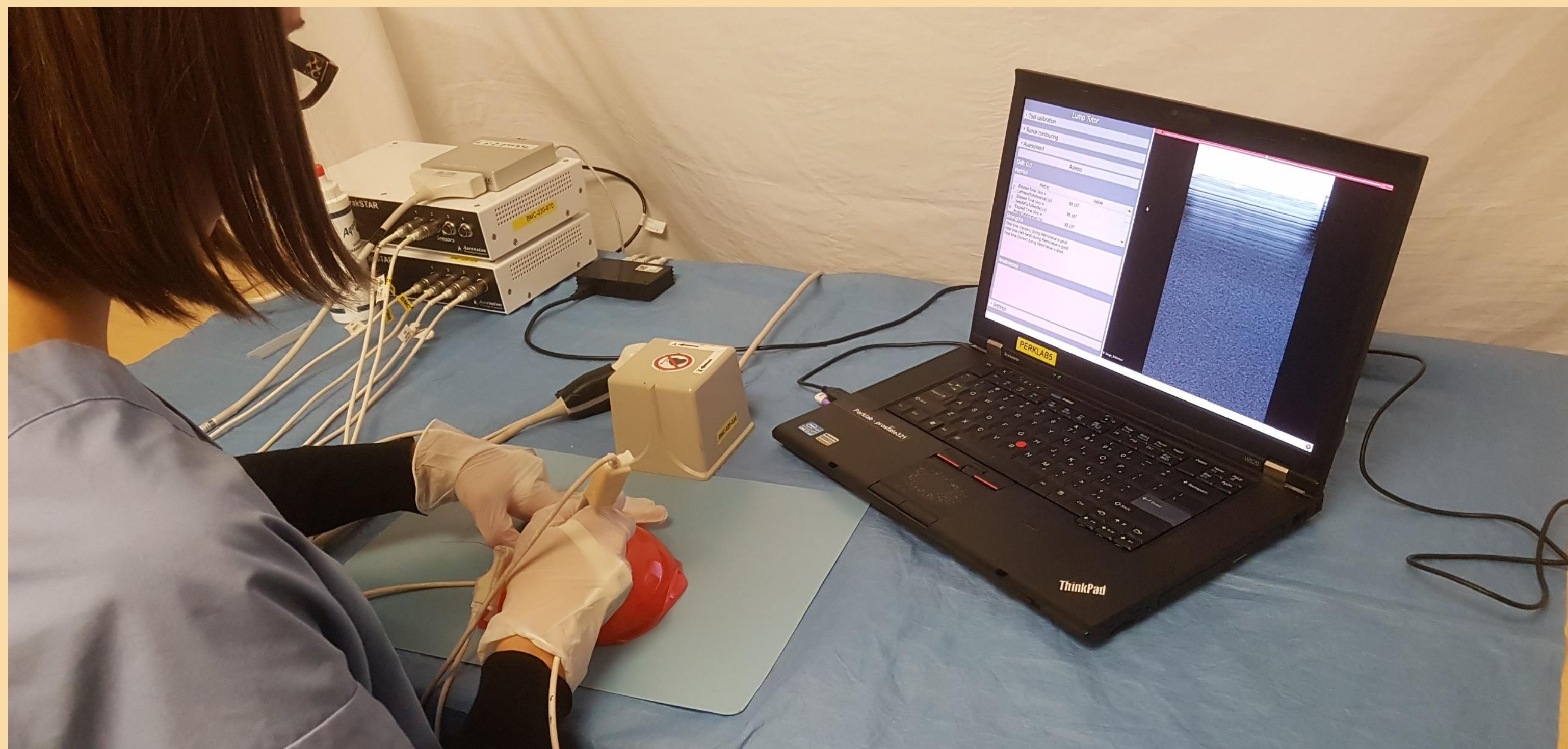


Fig 1. Breast lumpectomy training setup.

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

Objective

- Mathematically determine the minimal set of sensors required for automatic technical skills assessment in lumpectomy

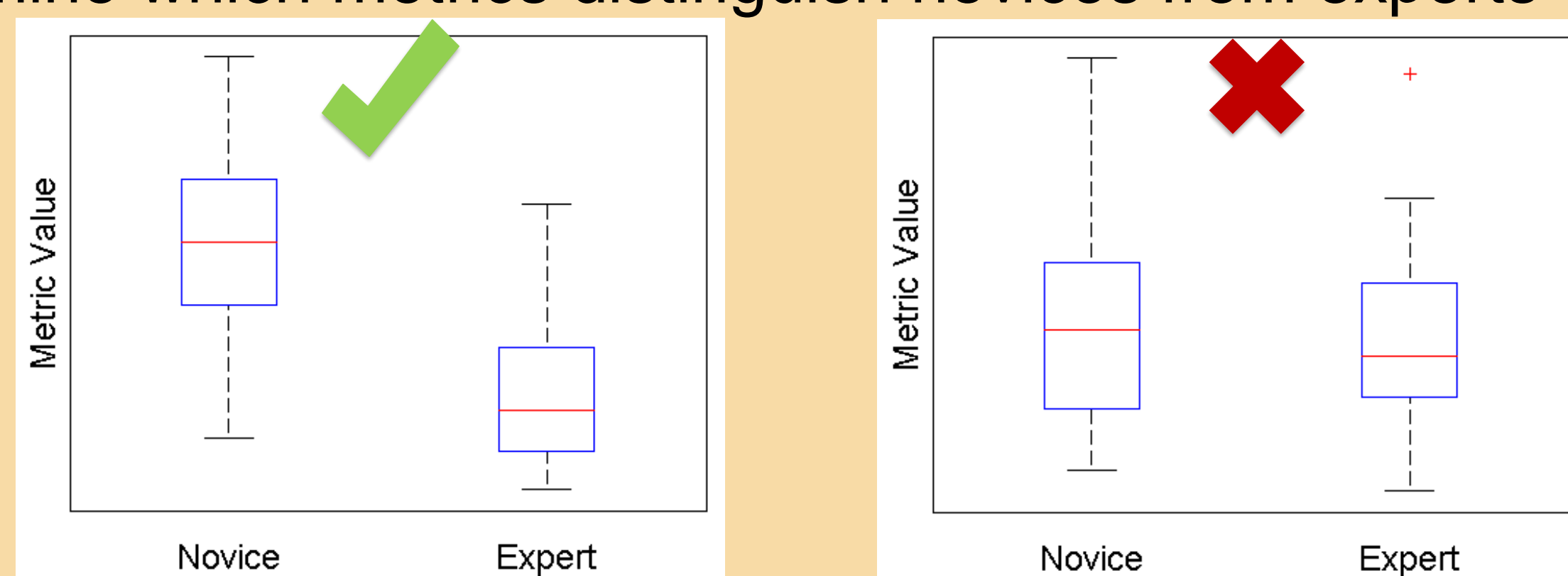
Methods

Performance Metrics

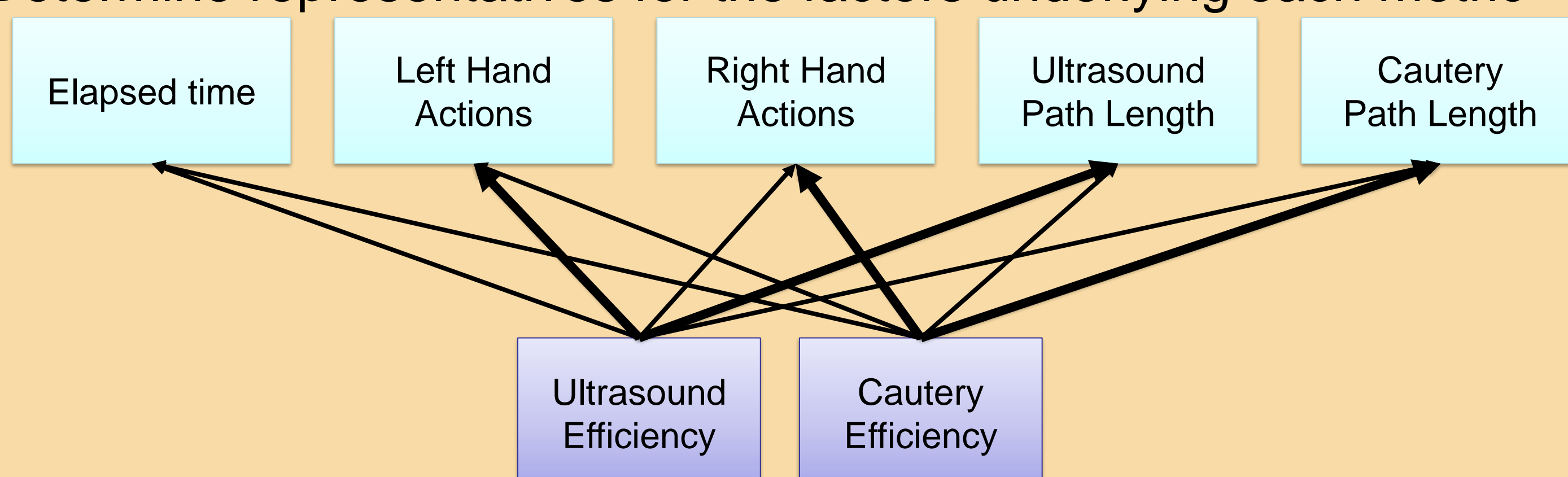
Completion time	Time required to complete all phases
Path length	Total distance travelled by the cautery, probe, left hand, right hand, and tumour
Rotational/translational actions	Number of rotational/translational actions of each hand, delineated by periods of rest
Tumour punctures	Number of times the cautery punctures the surface of the tumour
Tumour zones	Time the cautery tip is <0mm, 0mm – 5mm, ..., 25mm – 30mm, >30mm away from the tumour during excision

Representative Metric Formulation

- Determine which metrics distinguish novices from experts



- 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

Aspect of Technical Skill	Representative Metric
Excision efficiency inside safety margin	Tumour zone: 0mm – 5mm
Palpation efficiency	Tumour path length
Excision efficiency outside safety margin	Tumour zone: 20mm – 25mm

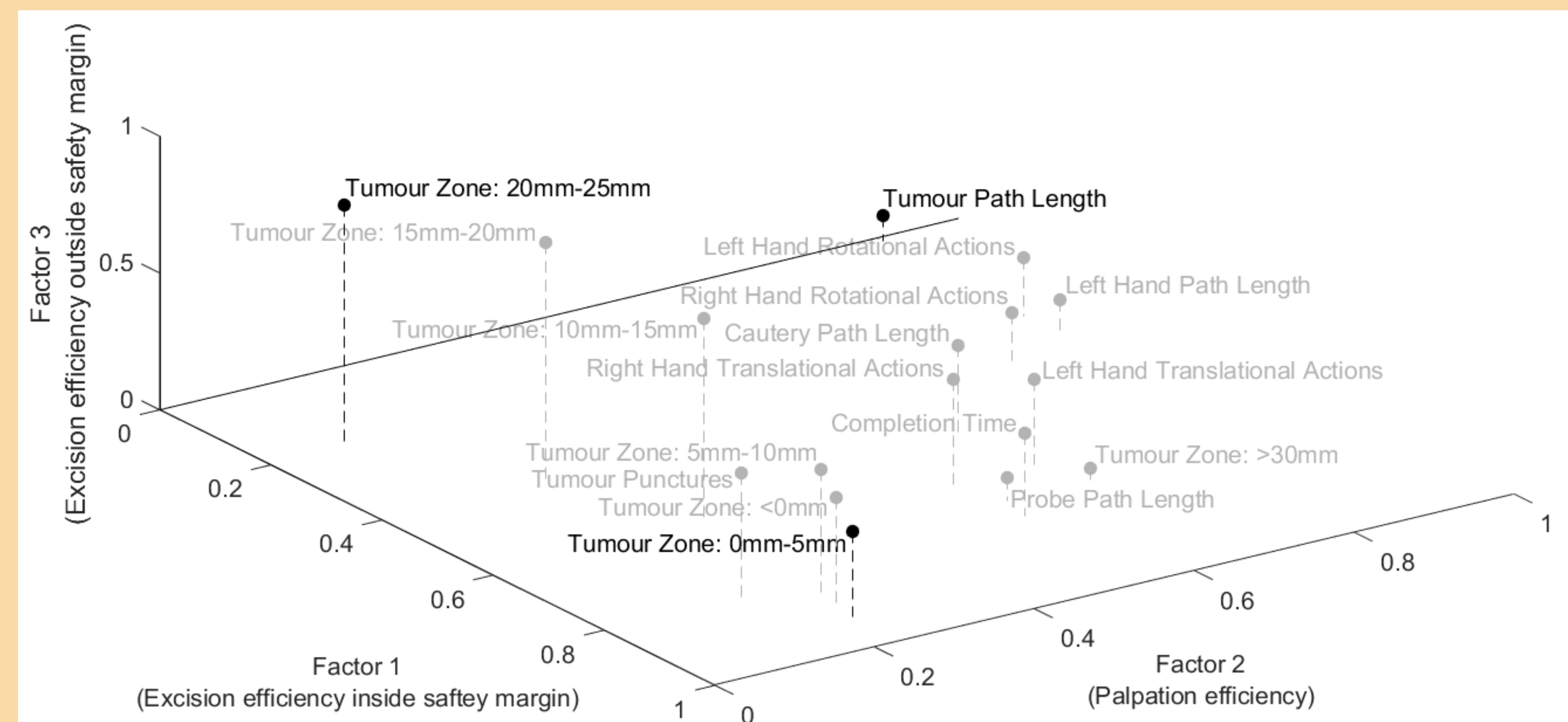


Fig 2. Loading plots of metrics onto factors identified with domain knowledge.

- Skill assessment accuracy: 88% with all metrics; 82% with representative metrics (difference is acceptable in practice)

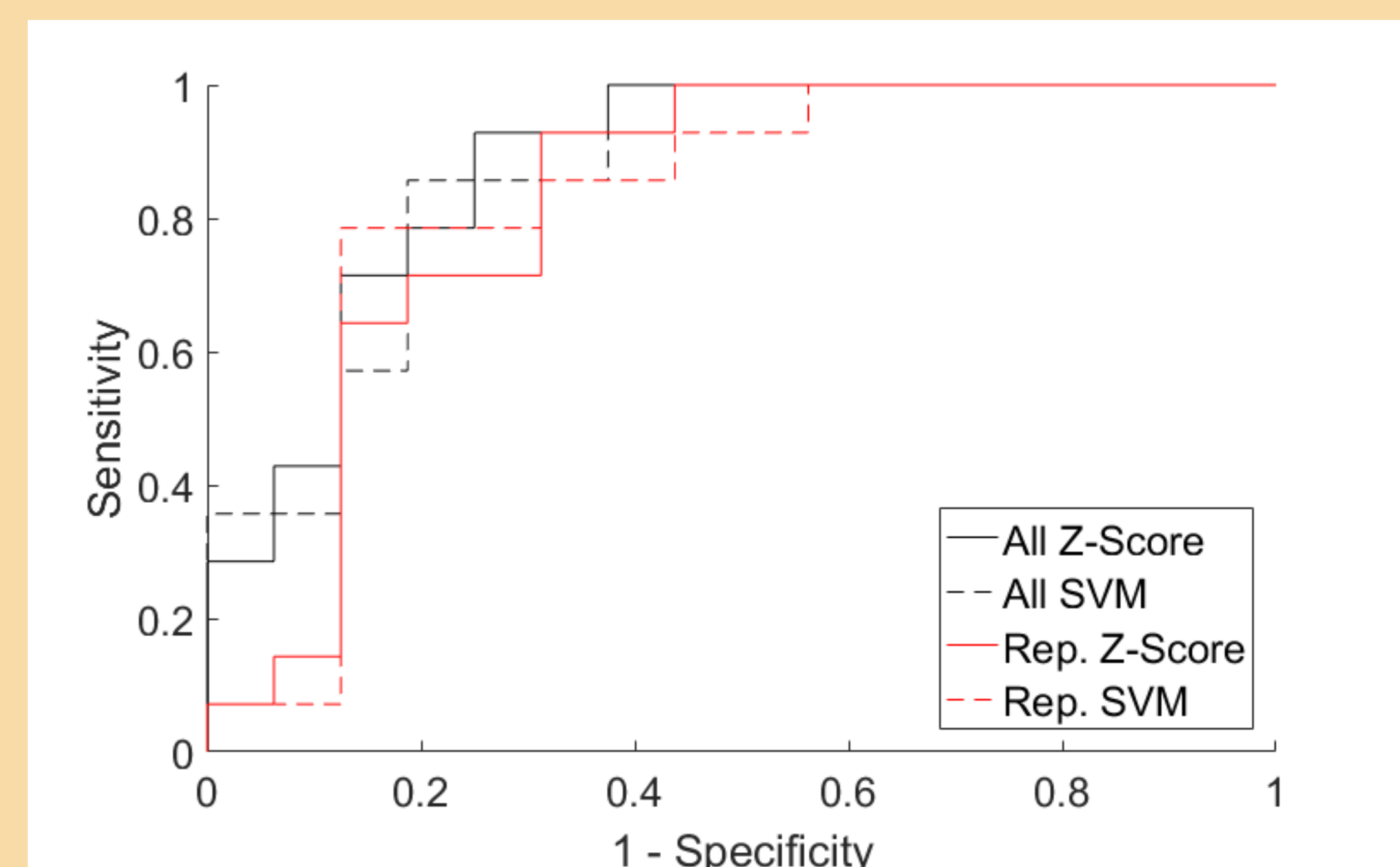


Fig 3. ROC curves for overall proficiency assessment using the z-score (black) and SVM (red) methods with all (solid) or representative (dashed) metrics.

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

- [1] Yeo CT, Ring J, Holden MS, Ungi T, Fichtinger G, Zevin B. (Nov 2017) Surgery Tutor for Computational Assessment of Surgical Competency: A Proof of Concept Study, William Ersil Research Day, Kingston ON.

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