**Motivation**

- Skill level can affect clinical outcomes after surgery
- Simulation (inanimate models, virtual reality, and more) offers many venues for practice of procedures, including patient-specific anatomy
- Limited tools exist for objective and quantitative assessment of surgical skill
- Rapidly advancing technology offers the chance for motion capture and motion analysis
- Motion capture, which is enabled by new technologies like EM sensing and VR systems, offers a new opportunity to provide objective performance feedback

**Current Skill Assessment Methods**

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<tr>
<th>Type</th>
<th>Definition</th>
<th>Examples</th>
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<td>Completion time</td>
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<td>Structured Grading</td>
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</table>

**Objectives**

- Explore the potential for a standardized, objective, and quantitative means of measuring technical competence based on analysis of the kinematics of endovascular tool tip motions
- Improve surgeon performance with real-time performance feedback of tool movement quality via haptic cues
- Increase efficiency of training for endovascular navigation

**Methods**

- Measure endovascular tool tip movement on two systems
  - Virtual reality (VR) training simulator
  - Telesurgical robotic system
- Translate movement features to haptic feedback cues to surgeon
- Assess impact of feedback on performance and training

**Preliminary Results**

Strong and significant correlations between motion-based metrics of endovascular surgical skill and performance evaluated with a structured grading tool for manual catheterization on an inanimate model (left) and on a virtual reality simulator (right).

**Conclusions**

- Motion-based metrics, particularly those that are based on the principles of motor control and capture movement quality characteristics such as smoothness, are strongly correlated to structured grading assessments of skill (Estroda et al., IEEE THMS 2016)
- Skill evaluation based on dexterity and motion economy while performing endovascular surgical procedures has potential for assessment and to provide as feedback during training

**Acknowledgement**

The authors gratefully acknowledge the support of the National Science Foundation Grant IIS-1638073