ACS 2025 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

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Research In-Progress

Towards a Robotic Minimally Invasive Surgery Assessment and Augmentation Platform for Visual-Haptic Acuity Development

Sergio Machaca; S. Swaroop Vedula, MBBS, PhD, MPH; Gina L. Adrales, MD, MPH, FACS; and Jeremy DeLaine Brown, PhD

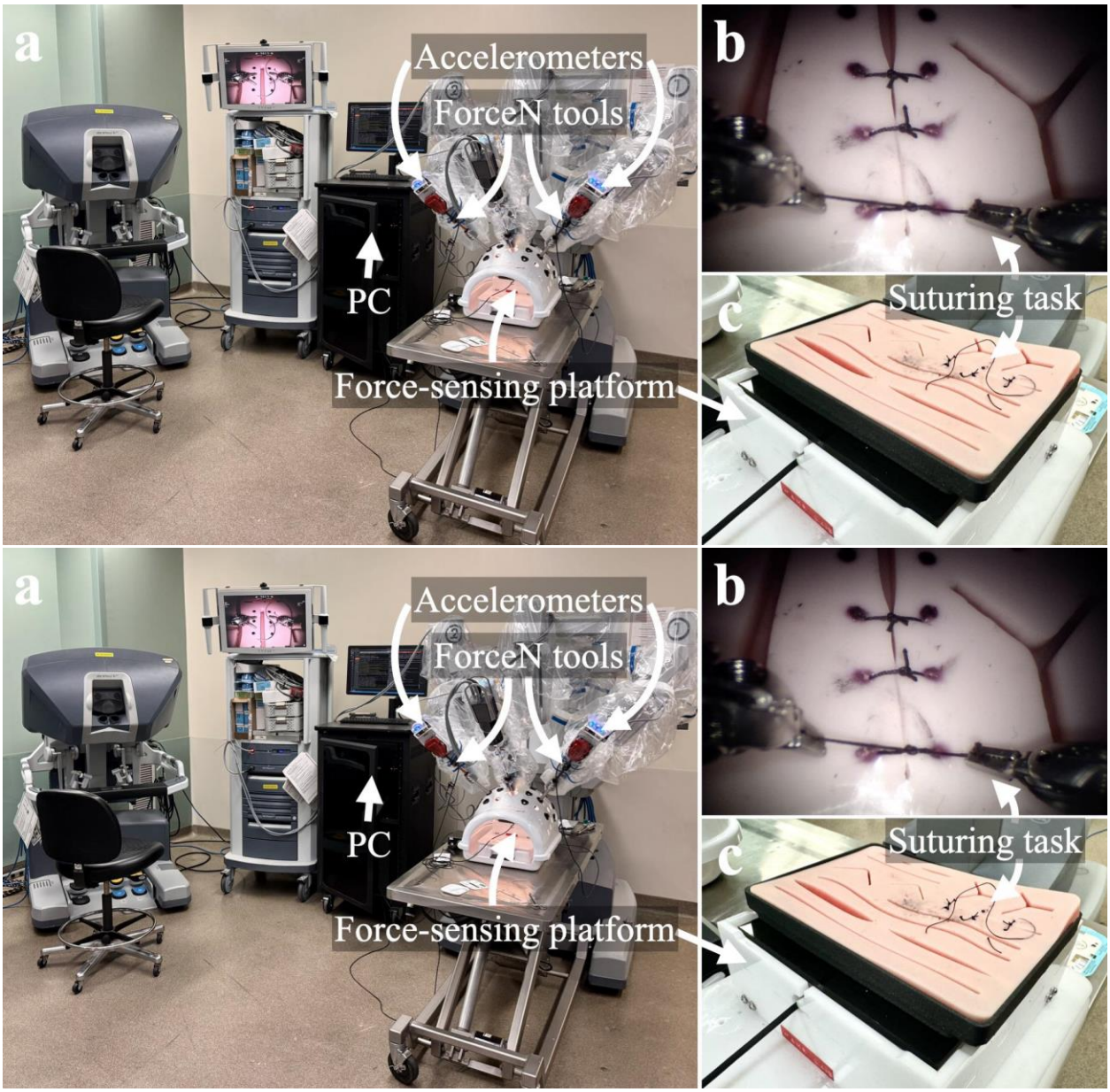
Johns Hopkins University, Baltimore, MD

Introduction: Up to half of the technical errors made by surgical trainees result from improper tool forces on tissue (Tang et al. 2005), which is further exacerbated in robotic minimally invasive surgery (RMIS) due to the lack of haptic feedback in most clinical RMIS platforms. We developed a metrics-based framework to objectively classify and evaluate trainee skill related to force production and provide customized haptic feedback based on measured skill deficits.

Methods: N=13 participants, comprising one surgical educator and twelve surgical residents from Johns Hopkins Medicine, were recruited for a pilot study. Participants completed one trial of a virtual needle driving task followed by three trials of an inanimate interrupted suturing task using a *da Vinci Si* Surgical System. As participants completed the inanimate task, task platform forces, surgical tool forces, surgical tool accelerations, Cartesian tooltip positions, and stereoscopic endoscope video were recorded and timestamped by our ROS-based framework (Machaca et al. 2022).

Preliminary Results: The surgical educator and residents applied an average of 0.01N and 0.08N of force on the task platform and 0.04 m/s^2 and 0.03 $m/s^2$of acceleration on the surgical tools, respectively. The percentage difference in applied platform forces (161.35%) and tool accelerations (33.43%) between the surgical expert and residents demonstrates clear disparities in surgical training task performance driven by skill level.

Next Steps: We will modify the task board to improve task consistency and add light-up buttons to register trial start and stop events across all data streams. We will then recruit 30 more participants of varying skill to complete six trials of the new suturing task. Metrics-based skill models will then be developed to classify trainees by experience level and dynamically tune multimodality haptic feedback provided by wrist-worn devices.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