ACS 2022 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research In-Progress

Automated Surgical Tasks Classification Using Surface Electromyography

Hajar Sharif; Heidi Phillips; Jennifer Kuzminsky; Seung Byum Seo; Leslie McNeil; and Thenkurussi K. Kesavadas

University of Illinois at Urbana-Champaign, Urbana, IL

Introduction: Excellent surgical and microsurgical skills are critical to avoid morbidity and mortality in high stakes surgical patients. Gaining surgical skills requires significant practice and mentorship, yet opportunities to gain on-the-job surgical training are scarce. While administrative, legal, and ethical pressures understandably preclude exposure of surgical patients to novice surgeons on the steepest part of the learning curve, surgical training is negatively impacted. In addition, fewer medical training programs use live animal models in the delivery of medical education due to humane concerns and societal pressures and perceptions. As a result, development of non-living models and simulations is critical to advancement of surgical training in medical education. Evidence suggests that many highly technical skills may be acquired and refined outside of the operating arena through use of surgical simulations. Validation of any surgical simulation system is needed to ensure skills transfer to real-life surgical situations. Robust and quantitative skill assessment methods are required to perform such systems validation. One first step toward development of such quantitative methodology is to devise techniques that automatically differentiate among various surgical tasks using hand gestures. Surface electromyography (sEMG) signals have been widely used in hand gestures classification for different applications.

Methods: In this work, machine learning techniques have been presented and validated using experimental data to classify surgical tasks. sEMG signals were collected from the dominant lower arm of more than 40 participants performing common surgical tasks such as passing suture and tying knots on a high-fidelity synthesized tissue model. The cohort was composed of participant groups with differing levels of knowledge, ranging from pre-clinical veterinary students to expert veterinary surgeons. The collected data were classified using a 3-layer convolutional neural network.

Preliminary Results: Over 90% accuracy was obtained by applying the presented classification method on a subset of the collected data, i.e. the data from expert participants.

Next Steps: The presented method will be applied to the entire dataset to include data from novice and intermediate-level participants.