ACS 2023 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Promoting Technology and Collaboration

Using Virtual Reality Performance Data to Power and Inform Intraoperative Performance Analysis

Anand Malpani, PhD; Jeff Berkley, PhD, and Mark Brentnall

Surgical Science, Mimic Technology, Seattle, WA,

Background: Virtual reality (VR) simulation-based training has proven benefits. Automated metrics for skill assessment is one of its advantages. However, VR training is less effective without targeted, deliberate practice and personalization for the learner. At the same time, sensor technologies and artificial intelligence are being validated to automate performance analysis in the real world setting of the operating room (OR). The rich information available within VR simulators, when combined with intraoperative analytics, can transform surgical performance review.

Technology Overview: Beyond summative performance metrics, data extracted from the VR environment can provide additional information. Such data includes 2-D or 3-D images, pixel labeling of objects within these images, motion information about virtual objects like instruments and needles, events like collisions and drops, and more.

Potential Application in Surgical Simulation and Education: We present two ways VR simulation data can boost intraoperative analysis of surgical performance. Firstly, the increasingly realistic modeling of graphics and physics provides a sandbox for generating data that can train machine learning algorithms to analyze real world data from the OR. This is called "synthetic data" in the broader AI community. For example, automatically annotated image datasets can be exported from a VR simulation scene, instead of relying on human annotations of instruments, anatomy, and other objects. Secondly, the increasing breadth of surgical skills training provides a programmable tool to tailor the learning of the user by using their performance analytics from the real world (OR). For example, an intraoperative analysis showing poor performance on a skill, say sharp dissection, would generate a personalized recommendation of sharp dissection VR exercises for lab training.

Potential Opportunities to Collaborate: Researchers interested in developing AI for surgical video analysis can partner up with those developing VR simulation to validate the use of synthetic data in for applications like anatomy detection in images. Likewise, researchers studying intraoperative surgical performance data can collaborate with researchers interested in enhancing the VR simulation experience to enable closed-loop training (from OR to VR to OR).