

ACS 2026 Surgeons and Engineers: A Dialogue on Surgical Simulation

P-A-06

Challenges in Surgical Education

Challenges in Motion Capture Technology to Assess Surgeon Technical Skills

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Background: Technical dexterity is vital in surgery and multiple technologies can be used to assess a surgeon's technical skills. Examples include flexible sensors incorporating accelerometers and gyroscopes, and AI software that extracts surgeon motion from video. In our research, we use motion capture technology, which uses cameras to track 3D positions of reflective markers placed on surgeons and their surgical instruments. Although motion capture technology is able to create detailed time series including instrument position and speed, surgeon joint angle, and images of motion path, it has many challenges.

Current Challenges: Motion capture systems take up space. Our system, which includes 18 OptiTrack Flex 13 cameras, requires a 36 square meter room to position the cameras and their tripods along with associated cabling and other hardware. Our data collection sessions, which usually involve testing two participants at a time, require 2-3 hours to capture 30 trials from each participant plus 30 minutes for camera calibration, and continuous equipment monitoring by motion capture experts. We have noted challenges streaming kinematic data from the OptiTrak software (Motive) to real-time processing software (MATLAB), including sampling rates as low as 2 frames per second. Additionally, marker obstruction is common, resulting in unpredictable jumps in the time series. (Figure) Finally, much of the data analysis must be performed manually.

Need of Innovation: The following innovations will improve motion capture technology: • Innovations to improve sampling rate, such as combining motion capture and data tracking into a single software program • Robust systems (such as AI) to estimate location of obstructed markers • Elimination of jumps in the motion path related to unrealistic marker locations • Development of a turn-key system that allows data to be collected without staff monitoring the trials

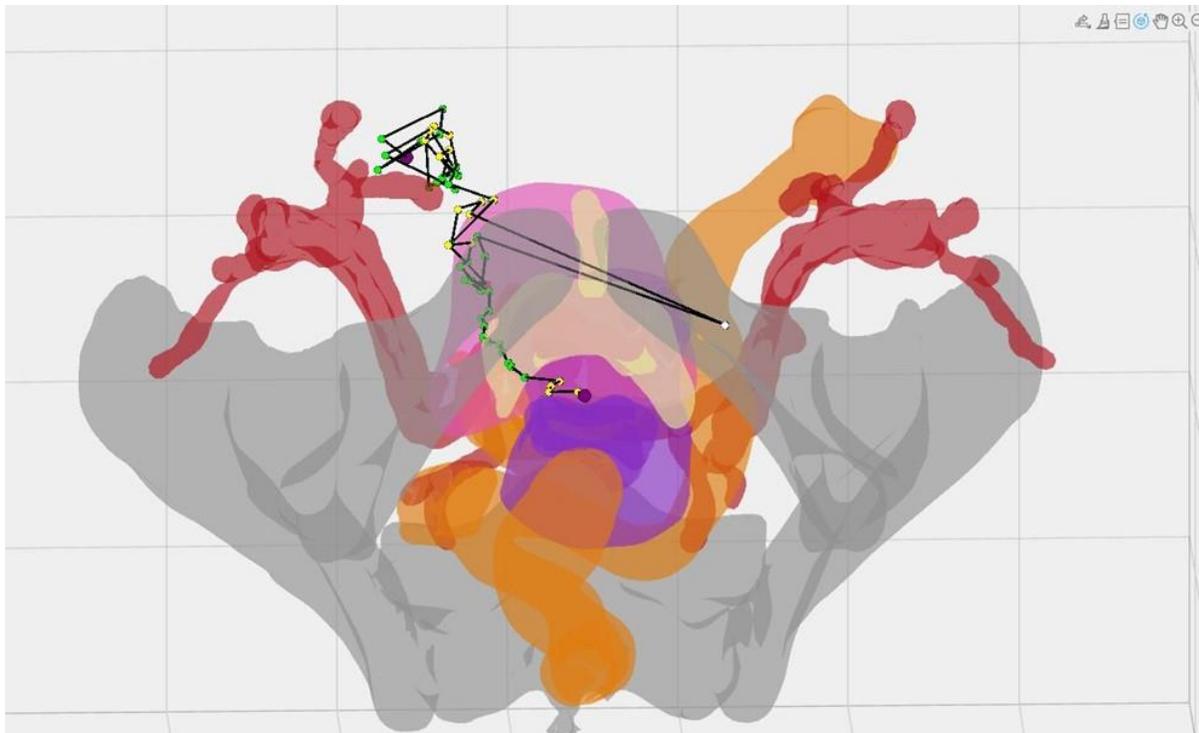


Figure. Successful Retropubic trocar pass, showing motion path length impacted by marker obstruction and low sampling rate. White marker represents a “jump.”