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

Research Abstracts

Efficient assessment of surgical maneuvers: Human verses Machine

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Introduction: Human observers cannot detect and track technical performance the way computers can. In this study, we trained an algorithm to automatically identify gestures in surgery.

Methods: Thirteen attending surgeons and eleven medical students performed a suture task on our variable tissue simulator. They placed 3 interrupted instrument-tied sutures on two opposing pieces of material. Each participant performed the task 4 times and a total of 96 videos were analyzed. Six Surgical gestures were defined: G0 - nonspecific motion, G1 - Needle passing, G2 - Pull the suture, G3 - Instrumental tie, G4 - Lay the knot G5 - Cut the suture. For the automatic gesture recognition, a 3D Resent -18, was trained and its output was fed to Long Short-Term Memory (LSTM) unit. Networks were trained in a 5-fold cross validation manner.

Results: The system achieved a frame wise accuracy of 75.7±4.7%, frame wise F1 of 69.2±5.6, F1@10 of 64.6±3.8 and Edit distance of 55.7±2.6. All the gestures, except for G5, took the medical students significantly longer. Detailed analysis revealed that gestures G0 and G1 took the students approximately 1.9 times longer than the surgeons ($p < 0.05$), gestures G2, G3 and G4 took approximately 1.5 longer ($p < 0.05$). There was no significant difference for gesture G5.

Conclusions: It is well established that attending surgeons are faster than medical students, however this evaluation is typically provided as a global, time-based metric for the full task or procedure. In this study, using automatic gesture analysis, we were able to analyze time differences on a gesture level. We identified that two specific gestures (nonspecific motion and needle passing) accounted for the largest delays in the students' performance. Thus, automatic analysis of gestures may provide the trainees with more specific, and actionable information regarding their performance as well as reduce the time and effort required from experts for providing feedback.

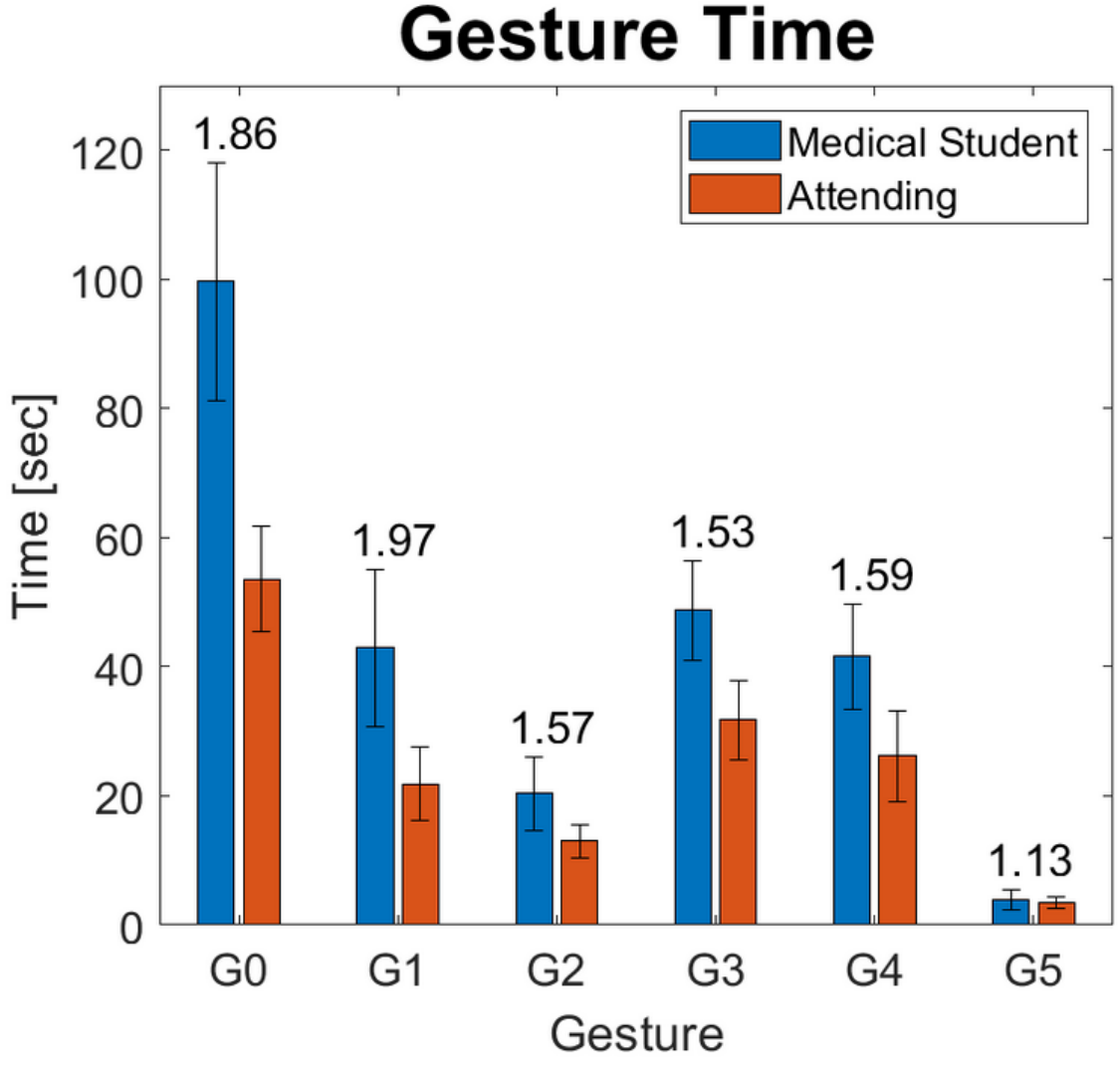

Figure 1: Total Time per Gesture by Training Level. Number above bar indicates the ratio between the gesture time of the medical student and the attending.