

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

### Research Abstracts

#### Characterization of Surgical Movements as a Training Tool for Improving Efficiency

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**Introduction:** Surgical experience is often reflected by efficient, fluid and well calculated movements. For a new trainee, learning these characteristics is possible only by observation as there is no quantification system to define these factors. We analyzed the hand movement of surgeons with different experience level to characterize their movements according to experience.

**Methods:** Hand motions were recorded by an IMU (inertial measurement unit) mounted on the hand of 3 surgeons during a simulated surgical procedure. IMU data provided acceleration/deceleration and Eulerian angles: yaw, roll and pitch corresponding to hand motions as radial/ulnar deviation, pronation/supination and extension/flexion, respectively. These variables were graphically depicted and compared between 3 surgeons using time series analysis and dynamic time warping methods.

**Results:** Surgeon1 was the most and surgeon3 was the least experienced. The main motion of the hand during suturing, the roll motion, had the lowest range for surgeon1 and the greatest for surgeon3: 153, 164 and 194 degrees respectively. The video analysis revealed that surgeon1's low rolling range was complemented by maximal usage of their left hand that overall improved the economy of their movements. Acceleration in the x-axis, was highest for the experienced surgeon, 0.22 versus 0.09 and 0.07 m/s<sup>2</sup> for surgeon2 and surgeon3. Regularity of the movement sequences, (defined as variability between each repeating movement) was the highest for surgeon1 with no wasted moves, who also completed the task faster. Time series analysis of the angular changes clearly signified the difference between the surgeons correlating precisely with experience.

**Conclusions:** Surgeon's hand movements can be easily characterized and quantified by an IMU device for automatic assessment of surgical skills. These characteristics graphically visualize the regularity, fluidity, economy, and efficiency. The characteristics from an experienced surgeon might serve as a training model and as a reference tool for trainees.

Surgeon 1

Surgeon 2

Surgeon 3

Variation of Yaw, Pitch and Roll angles during a simulated procedure

