A Holistic Data Acquisition Framework for Robotic Surgical Skill Assessment

Computer Integrated Surgery II
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Introduction

- We have developed a hardware + software platform to collect motion and physical interaction data during the usage of the da Vinci Surgical System
- We used this platform to collect data from skilled and unskilled users performing a peg transfer task
- Finally, we created an app for visualization and analyzed for statistical features that distinguish the two groups
- Our platform can be used in the future to develop a method of assessing robot surgical skill that is objective, time efficient, and cost efficient.

The Problem

- Robot-assisted minimally invasive surgery (RAMIS) is quickly becoming the prescribed method of treatment for many different routine and non-routine surgical procedures.
- There is a need to ensure that all robotic surgeons have a minimal level of skill proficiency before they operate on patients.
- Current methods of skill assessment rely almost exclusively on structured human grading which can be subjective, tedious, time consuming, cost ineffective (raters are practicing physicians).

The Solution

- We created a ROS system to combines two existing surgical skill assessment platforms created by our mentors. Our system interfaces directly with the da Vinci and collects kinematic data of both the end effectors and manipulators. Simultaneously, the computer will receive data from the smart task board microcontroller, describing the forces exerted on the environment and high frequency accelerations of the endoscope and two instrument arms. Data is saved and verified to ensure the two systems are synchronized.

Figure 1: A system overview

- Our data visualization software allows user to select different streams of data and plot them over time. The user can select the time span to plot over and place desired plots alongside each other for easy comparison.

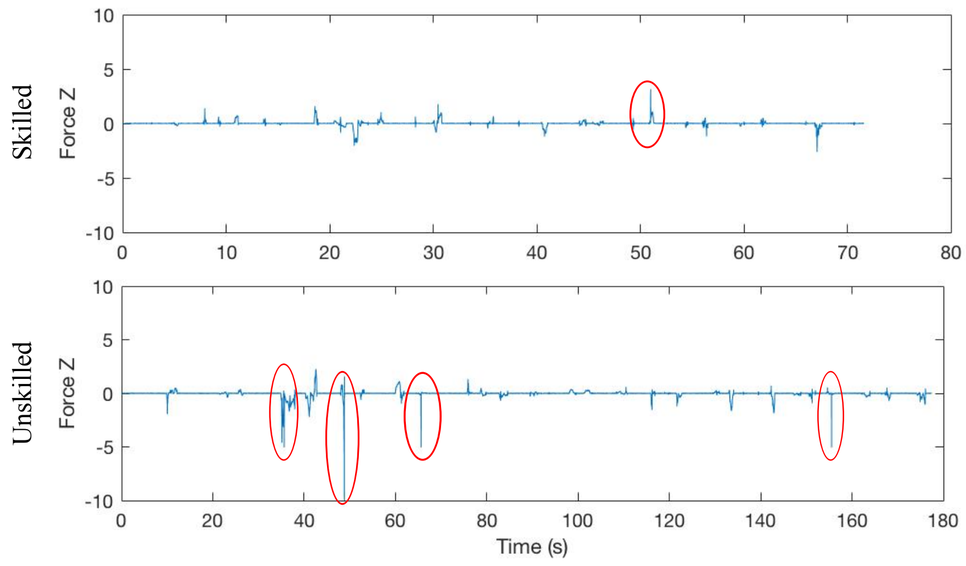

Figure 2: Skilled and unskilled force comparison. Spikes are larger in magnitude and more frequent in unskilled. Additionally, task took longer.

Outcomes and Results

- We analyzed data using n = 3 for the skilled and skilled groups to determine which metrics were significantly different between the groups
- This small pilot data set provides good reason to conduct further research into utilizing these metrics with machine learning algorithms that can be trained to predict the skill level of a user

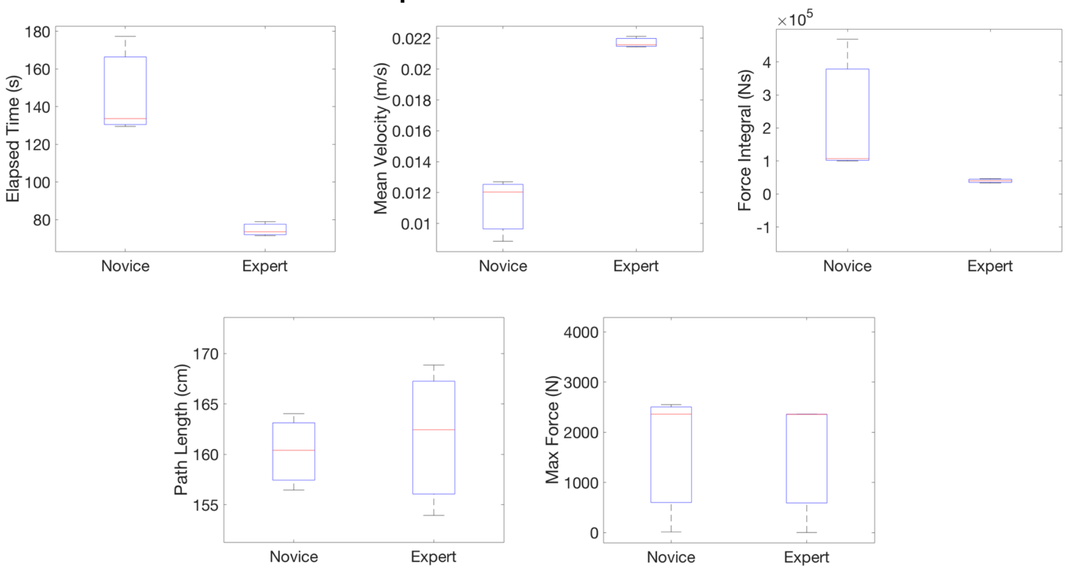

Figure 3: Statistics of selected features for novice/expert data collected during peg transfer exercises

Future Work

- Preparations have been made to pass on this work to future student researchers but current researchers may continue in Fall 2018
- Project may be continued by conducting large scale data collection in a clinical setting and applying machine learning algorithms to analyze the data

Lessons Learned

- Check for loose cables (da Vinci included…)
- Plan to encounter setbacks
- Determine what tasks have dependencies and what can be done in parallel

Credits

- Giacomo – DAQ software development, debugging
- Scott – Data visualization software, project management

Support by and Acknowledgements

- Thank you to our wonderful mentors
- Thank you to Anton Deguet for software support