How Cheap Can We Make a High Quality VR Surgical Simulator?

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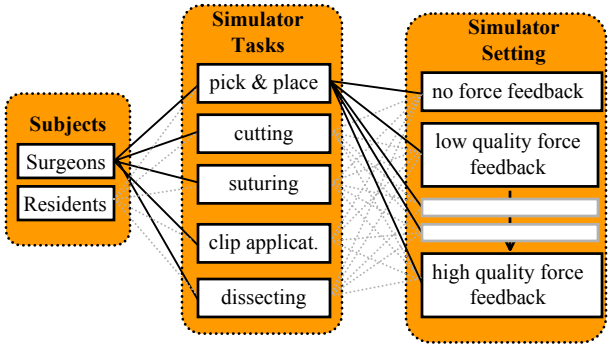
Goal

This project aims to determine quantitatively **which haptic (force-feedback) device design parameters have the most influence on surgical performance**, and how much they can be degraded before a significant deviation in surgical performance can be observed.

From this we can provide a functional specification for the most **economical** device **sufficient for the particular laparoscopic tasks studied.**

In the longer term, we are seeking to generalize our results so that we can infer **design specifications** for interfaces for arbitrary environments from a small set of standard tasks.

Experimental Overview



Hardware quality

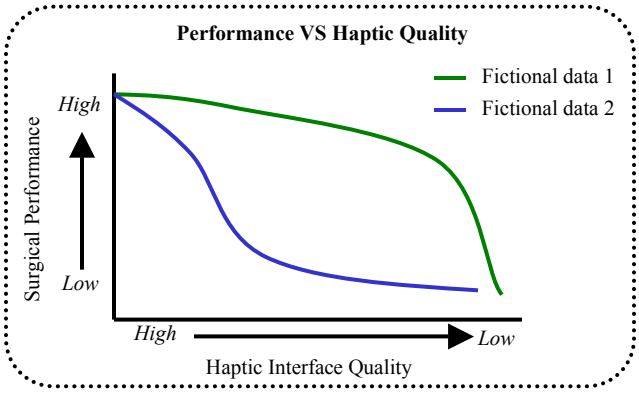
Inexpensive components make an inexpensive interface. We are modeling the characteristics of inexpensive components such as motors, transmissions and electronics, and incorporating them into the overall system behavior. Using these models, we can make a high quality interface emulate the characteristics of an inexpensive device.

Measuring Surgical Performance

A previously developed quantitative method [McBeth] that relates instrument kinematics to surgical performance will be expanded to include algorithms that take into account force and torque values. The following aspects of surgical performance will be included:

- Task Completion Time
- Tool Kinematics
- Forces and Torques
- Error Frequency

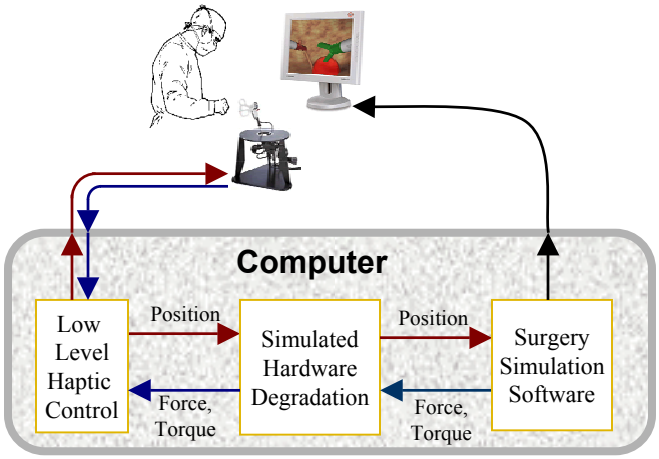
Experimental Question



Can haptic interface quality be degraded significantly before a change in surgical performance occurs [*fictional data1*], or will surgical performance change with even a small degradation of haptic interface quality [*fictional data 2*] ?

Software Implementation:

For flexibility, all hardware degradations are made in software.



References

•Paul B. McBeth, A.J. Hodgson, A.G. Nagy and K. Qayumi, "Quantitative methodology of evaluating surgeon performance in laparoscopic surgery". MMVR, January 2002

•K.E. MacLean, "Emulation of Haptic Feedback for Manual Interfaces", Ph.D. Thesis, MIT, 1996.

•Christopher R. Wagner, Nicholas Stylopoulos, Robert D. Howe, "The Role of Force Feedback in Surgery: Analysis of Blunt Dissection." Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems 2002: 73-79