Utilization of the NASA Robonaut as a Surgical Avatar in Telemedicine

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The concept of teleoperated robotic surgery is not new; however, most of the work to date has utilized specialized robots designed for specific set of surgeries. This activity explores the use of a humanoid robot to perform surgical procedures using the same hand held instruments that a human surgeon employs. For this effort, the tele-operated Robonaut (R2) was selected due to its dexterity, its ability to perform a wide range of tasks, and its adaptability to changing environments. To evaluate this concept, a series of challenges was designed with the goal of assessing the feasibility of utilizing Robonaut as a telemedicine based surgical avatar.

Method:
NASA's Robonaut was temporarily installed at the Houston Methodist Institute for Technology, Innovation & Education (MITIE) and evaluated by two robotic certified surgeons while performing multiple medical and surgical tasks via teleoperation, specifically: intubation, assisting during simulated laparoscopic surgery, preforming ultra sound guided procedures and executing a SAGES[i] training exercise.

Results:
Robonaut was able to complete all the tasks listed above; however, there was a significant learning curve in utilizing the robot for these procedures. A post evaluation analysis was performed and three areas were identified in need of significant improvement to enable advancement in the performance of medical procedures. These areas are: the tele-operator interface, the configuration of the "soft flesh" on the robot's hands that impacts grip positions, and the adjustability of the tool point to achieve better endpoint mobility and accuracy conducive to surgical applications.

Conclusion:
Robonaut was found to have significant potential as a tele-robotic surgical avatar; however, there are several capabilities that need to be addressed before it can realize this potential in a clinical setting. The teleoperator interface needs to be more intuitive and include, in a non-intrusive fashion, additional information to improve situational awareness. The control system requires an upgrade to easily allow the surgeon to control rotation of surgical tools not only around the grip location, but also arbitrary points along the tool, including the tip. The hand was originally designed to manipulate gross mechanical tools similar to a mechanics; however, do to the unique grips required in surgery and the refined nature of the instruments, the soft body of Robonaut's hands/palms as well as the grip/finger control need to be modified to be more conducive for medical and surgical procedures. With these improvements, Robonaut will be able to perform the above procedures more efficiently and also increase the number of procedures it can complete. Looking further out, it will be important to consider the ramification of time delay and loss of signal as part of the avatar control strategy.

[i] Society of American Gastrointestinal and Endoscopic Surgeons