Collaborative Surgical Robotics: Bringing Surgeons Back to the Operating Table

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Motivation and Objectives

Master-slave telepresence technology was originally put forward for remote surgery to allow surgeons to perform operations over distance. So far, although advances in robotics have helped achieving unprecedented operation intuitiveness and precision, little change was made to that master-slave working modality. Surgeons are still physically isolated from the patient's anatomy by the robot agent, which seriously impairs natural haptic and force feedback. Moreover, no patient rests assured when the surgeon is nowhere at the table during the procedure. So, why must surgeons be separated from patients even when they are physically at the same location? That's a question more and more people begin to ask about current robotic surgical systems. Therefore, our objective is to bring surgeons back to the operating table by reforming the technology modality.

Approaches

The approach derives from the evolvement history of industrial robots. At the beginning, robots working in industrial applications are usually called caged robots because they need to be fenced off from operators and workers. Until 2008, Universal Robots (UR) introduced collaborative robotics and made the first industrial robot able to work safely alongside human workers. Since then, collaborative robots (cobots) started to prevail in industry with their safe and collaborative features. Now, robotics is evolving along a similar path in the operating room. By incorporating collaborative features into surgical robotics, surgeons will be able to work safely and collaboratively with robots at the operating table.

Results

As is shown in Fig. 1, a collaborative robotic arm-assisted laparoscopic imaging system was firstly built for proof of concept. The collaborative robotic arm prototype was designed towards medical requirements. The camera was fully inserted into the abdomen model and driven magnetically by the actuator. The actuator was mounted at the end of the arm through a force/torque sensor. The imaging camera can be automatically controlled by the robot at the surgeon's command or manually through a joystick by the surgeon himself/herself if any incident happened. Control of the laparoscopic camera does not necessarily rely on the robot. The surgeon can take over anytime there is a need. In this way, the relationship between the surgeon and the robot was changed form master and slave to partners. Preliminary tests have been performed on the prototype of the system, which provides proof of the concept.

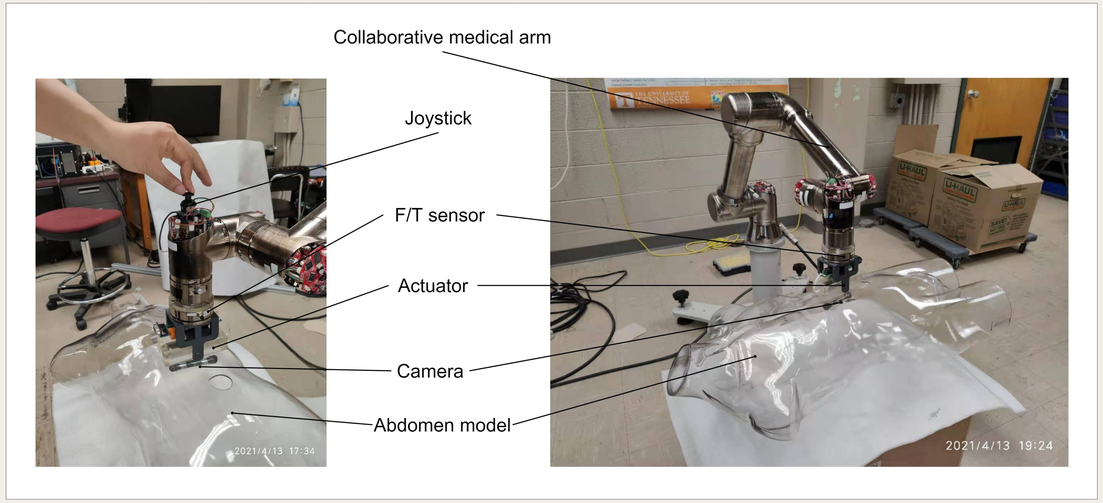


Fig. 1 Proof of concept prototype of a collaborative robotic arm-assisted laparoscopic imaging system

Conclusions

Collaborative robotics has so far changed the way of industrial automation. Now, it's time to introduce cobots to the operating room and start to bring surgeons back to the operating table with the patients. This abstract shows our most recent work on a collaborative laparoscopic imaging system. In future, collaborative robotics will be integrated with other surgical instruments to have a full collaborative surgical robot system. By that time, surgeons will be able to perform right at the table with robotic assistance, as well as natural haptic and force feedback. The natural surgical operation will be back with more ease and better experience.