Increasing Accessibility to Medical Robotics Education

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Abstract

Advances in robotics and computer technology have enabled much complex work to be achieved via remote control. Using such technologies, telerobotics enables surgery to be performed over long distances, as demonstrated by the first transatlantic procedure in 2001 executed by Dr. Marescaux in Strasbourg, France. In the U.S. alone, the market for medical robotics and computer assisted surgery equipment was worth an estimated $648 million in 2008 and is projected to reach $1.5 billion by 2014, with surgical robot systems as the largest product segment (54% market share in 2008) and is expected to increase to 65% by 2014 as (BCC Research, 2009). The potential advantages of robotic surgical systems over human-controlled surgical procedures include increased degrees of freedom for manipulation; elimination of the fulcrum effect in minimally invasive surgery; reduction of tremors that the surgeon may have; motion scaling to increase accuracy; reduction of fatigue; restoration of depth perception and haptic (tactile and kinesthetic) perception; automation of basic surgical tasks; and potentially enabling the performance of complex procedures not previously possible. More importantly, the expected advantage of using robotics for telesurgery is the potential to save lives remotely, reducing both the need for travel and the time delay in receiving treatment.

Even with these potential advantages and the projected market growth of telerobotics for surgery, poor technology design and implementation, often due to poor understanding of human factors issues, remains a major problem. For example, the problem of managing communication outages, delays, and bandwidth variation during the transfer of data between the master control (surgeon site) and the telemanipulator (patient site), and the lack of haptic feedback from the robotic arm impose a high cognitive and physical demand on the surgeon. Effective teleoperated systems require both technical solutions and human factors engineering. In addition, public acceptance of telerobotics in healthcare is lacking and requires a fundamental change in attitude and aptitude to understand and appreciate medical telerobotics.

To address these issues, a new project at Tufts University in Massachusetts in collaboration with Ecole des Mines de Nantes in France has been launched aimed at the education of the broader public, and especially school-age children, in the concept of medical telerobotics. With a primary goal of exposure and engagement towards this general field, and a secondary one of filling the pipeline of trained engineers interested in telerobotics for medicine, a team of interdisciplinary graduate students has been formed (with backgrounds in mechanical engineering, computer engineering, electrical engineering, engineering management, human factors, and cognitive psychology). Working together, albeit remotely across the Atlantic, the students on both campuses were tasked with the challenge of building an "education friendly" prototype for a teleoperated robotic surgical system. System requirements dictated that the product be inexpensive (thus, accessible to classrooms), kid-friendly and safe, easy to transport/setup/control, allow local and remote manipulation, and age-scalable (adaptable to

primary, secondary, and university level settings). Finally, an associated curricular outline needed to be conceived to fit with existing classroom standards and current material being taught in order to facilitate eventual widespread educational adoption.

This paper highlights the work done on this project, as well as describes some preliminary pilot testing and results performed by the group both locally within single-classroom education settings as well as early explorations into distance learning possibilities through remotely connected telerobotic sites. Further directions and plans towards extending the initial tests towards a larger educational study are also detailed.

References

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