Thesis Project Portfolio

Analysis of Gesture Recognition Models Using Accessible Robotic Surgical Systems

(Technical Report)

An Actor-Network Theory Analysis of the Unsuccessful Robotic Hysterectomy of Laurie Featherstone

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical work and STS research are connected through the goal of improving the safety of robot-assisted surgical procedures. Increasing numbers of surgeons across the world are performing surgeries with the use of robotic systems instead of through traditional methods, but the use of these robotic systems introduces new safety concerns. While the aim of both my technical and STS research projects is to address matters of safety associated with robotic surgery, the two works differ in the way that they explore safety improvements. My technical work focuses on identifying the hand movements that surgeons make while using a surgical robot in order to address incorrect actions, while my STS research explores the social factors that contributed to an unsuccessful robotic hysterectomy case in order to foster better understanding of how interactions among humans and organizations affect robotic surgery. Thus, while my technical work and STS research approach the improvement of robotic surgery from different angles, the theme of enhancing the safety of robotic systems is consistent across both projects.

My technical work uses machine learning to identify gestures that occur during robotic surgery and investigates how well two accessible methods to collect the surgical data perform. The two platforms to gather data are the Raven and the Data Collection System (DCS). The Raven is an open-architecture surgical robot which can collect video and kinematic data based on motor encoder values and forward kinematic equations. The DCS is an independent system that uses a trakSTAR to collect kinematic data from a set of sensors that can be attached to graspers that control the Raven. I fed the data from these two systems into a Temporal Convolutional Network (TCN) model to analyze how well the gestures from surgical trials could be identified. The results can be used to evaluate safety incidents and provide simulation-based training and assessments to surgeons.

My STS research also explores how to improve the safety of robotic surgery, but from a social standpoint. I investigate how negative team dynamics, lack of quality care, and legal limitations led to complications with patient Laurie Featherstone's robotic hysterectomy. To complete this analysis, I apply Actor-Network Theory (ANT) to examine the weak associations among the actors involved with the unsuccessful surgery. My research provides understanding and insight into how social factors can contribute to problems with robotic surgery and gives social groups grounds to take action to address these issues.

Working on these two projects simultaneously allowed them to benefit in ways that would not have been possible had I worked on them separately. My technical research gave me a solid scientific background and hands-on experience using robotic surgical systems, which showed me how essential it is to receive robotic surgery training. This added further motivation for me to analyze the legal restrictions on training in my STS research paper. On the other hand, my STS research showed me how important it is to address all weak links in a network to understand how the network failed. One of the weak links in a robotic surgery actor-network is often the lack of technical expertise connecting the surgeon with the robot; this increased my enthusiasm to strengthen that link through my technical research. In summary, working on my technical and STS research projects together this past year provided a comprehensive sociotechnical approach to improving the safety of robotic surgery, and each work added to the quality of the other.