

A doctor is often characterized by his or her ability to provide medical assistance. While I never intend to perform an operation on a patient, my endeavors into robotics and computer vision will push the forefront of medical technologies and aid the next generation of physicians. The influx of robots and automation in operating rooms in recent years is only the start of a huge modernization in medicine, which will not only reduce patient recovery times but also save lives. While I have pursued these interests from a general robotics perspective in the past, now that I am a PhD student at Johns Hopkins University I am able to develop theory and practical applications to better the medical workflow.

My undergraduate career at University at Buffalo was marked by participation and leadership in a variety of engineering-related endeavors in the areas of autonomous ground vehicles, haptic interaction, and computer vision. My experiences in the Automation, Robotics, and Mechatronics (ARM) Lab, Vision and Perceptual Machines Lab, role as president of the undergraduate Robotics Club, and research as a Robotics Institute Summer Scholar at Carnegie Mellon University helped cultivate my passion for developing new ideas, advancing technology, and teaching others.

Through complications with the Robotics Club's entry into the Intelligent Ground Vehicle Competition, I developed the necessary skills to lead a group of novice undergraduate colleagues in a contest dominated by masters students. At the start of my presidency, the club required rebuilding due to a large number of senior members who graduated. Our main project required implementing advanced mechanical and intelligence techniques for developing an outdoor vehicle that could autonomously navigate multiple obstacle courses, which many younger students were not familiar with. As a result the club required reevaluation in order to continue with our international competition. As part of my initiative to regain membership, I pushed development of a workshop series, including collaboration with the Society of Hispanic Engineers (SHPE) in creating Matlab tutorials, as well as through a semester-long beginner project. This allowed our new members to familiarize themselves with integral material and be able to contribute to our more advanced vehicle. Despite being one of the youngest teams at the competition were able to place 7th in our design group of 26 teams.

As a leader there are two key things I emphasize: passion and knowledge. Passionate people tend to be more productive and in general are happier. It has been my experience that exploring unique opportunities is imperative to growing as an intellectual. In the Robotics Club I was able to give people the resources to undertake creative activities which helped build teamwork skills, time management, and the ability to think independently. Regarding knowledge, it is easy to take open source code and hack together a robot without gaining an underlying intuition of how concepts work. It takes learning the math and implementing algorithms to truly understand how these models can be used. I also focused on this when I led my senior design group to develop an entry into the Solutions in Perception Challenge this past spring. Whenever we had to implement a new computer vision technique I would ensure everyone understood the theory behind each idea.

Besides having a positive effect on the community, presenting to children and other members of the public has an important role in expanding one's technical abilities. By explaining complex material in an easy to understand manner it forces you to think about problems differently and to see how they affect the world at large. As a sophomore and again as a junior, under the guidance of Dr. Venkat Krovi, I introduced underrepresented middle and high school girls to robotics at the

American Association of Undergraduate Women (AAUW) Tech Savvy Conference. Aside from my talk, which explored the differences between fantasy and reality in terms of how Hollywood portrays robots, we experimented with the use of haptic devices (force feedback controllers) in simulation. Each girl attempted a manipulation task – which I created – using a Novint Falcon haptic device with and without haptics enabled. They found that the added sense of touch allowed them to complete the task with many fewer mistakes. Since then I have developed a comprehensive set of outreach material which has been presented at the Buffalo Public Library, Buffalo Museum of Science, and to elementary and high school classes. I will be continuing this type of work at Hopkins in the near future by helping teach high schoolers how to develop code using a BoE Bot for our yearly Robo-Challenge.

The transition from mechanical engineering classes as an undergraduate to computer science classes in graduate school has been smooth. I attribute this in large part to my practical experience gained through the Robotics Club and various research activities, most of which involved some type of coding. Learning about design and controls freshman and sophomore year was fascinating and prompted me to delve further into the mechanical aspects, however, I later learned that my passion tended to be closer to algorithm design and problem solving. While I do not have the traditional computer science training, I think the rigor of my undergraduate major and large focus on math has put me ahead in some ways. My formal background in areas such as systems and dynamics compliments the mathematical theory behind ideas in multi-view geometry and vehicle autonomy. Additionally, by taking advantage of numerous open courseware lectures available online and applying the material in my everyday work, I learned about data structures, algorithms, machine learning, and other topics that did not fit into my undergraduate course schedule.

There are two driving forces in my focus on medical robotics. Foremost, contributing to the advancement of medical techniques will help save lives and increase the fluidity of doctor-robot-patient interaction. While machines such as the DaVinci medical robot have been slowly creeping into hospitals for almost ten years, there are still issues using these machines in the operating room. While there are significant advantages to robotic minimally invasive surgery, the duration of these procedures can be several times longer than with traditional techniques. The second driving force relates to the underlying theory behind robotics and computer vision. Learning about algorithms within problems like segmentation and activity recognition has shown how elegant some practical mathematical models can be. There are many areas in the medical domain that have yet to be explored, like video monitoring and room automation, which I discuss in my research proposal.

A disconnect between the engineers that create medical devices and the doctors who use them sometimes results in procedures that are counterintuitive to an experienced surgeon. This is what led me to pursue my interest in Johns Hopkins for graduate studies. While at Hopkins, I have already had direct contact with doctors at the medical school and am developing a tool to aid robotic laparoscopic surgery. Ultimately, I am very interested in theory but am also keen on ensuring the theory has direct applications that can be used for real problems. Working with Dr. Russ Taylor, Dr. Greg Hager – two forerunners in this area – and others will allow me to continue in this direction and have a tangible impact on the world.