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Laidlaw 2021 Application
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PROJECT DESCRIPTION
Minimal Robotic-Assisted Telesurgery for Cataract-Induced Blindness

I propose to work on a research project aimed at building a robotic-assisted telesurgery platform that enables surgeons from afar to conduct surgical procedures in underserved regions of the world. Over the next two summers, my final prototype, as a deliverable, will be designed and tested to allow for tele-robotic cataract eye surgery.

To quickly explain, cataract is an eye disease in which the proteins of the naturally clear lens break down, interfere with one's vision, and later cause blindness. Cataracts are one of the leading causes of blindness globally and surgery is the only known treatment to have one's eyesight restored. Cataract surgery involves replacing the clouded lens with an artificial implant called an intraocular lens. Among all the possible methods of cataract removal and lens implantation, manual small incision cataract surgery (MSICS) is the fastest and least technology-dependent procedure. This is particularly relevant to allow us to work within the financial and accessibility constraints of many under-resourced locations worldwide.

My research focuses on developing a telesurgery option for MSICS, connecting eye surgeons with every person who needs their expertise most. Leveraging the precision of robotic components, the platform includes two main devices: the operating station and the surgeon console. The operating station can consist of one microscopic camera and two robotic arms: one being a cable-driven forceps, another being modular such that new instruments can be swapped. Both robotic arms can achieve 6 degrees of freedom, giving the surgeons flexibility similar to their wrists while scaling down their movements to millimeters for a greater sense of control. The surgeon console has two ergonomically-designed handles, equipped with IMU sensors to capture hand motions and transmit these movements to the remote operating station. By the end of the research, my robotic system will be able to perform the movements required to perform MSICS: make a 1-3mm incision, enter through the incision, retrieve one tiny piece of paper, and then exit with it through the same incision.

Although the scope of my research only covers one specific type of eye surgery, this hardware platform can be modified and extended to address other simple – or even more complex – surgical procedures. For example, the operating station can be miniaturized to accommodate the instruments for brain tumor surgery, another type of surgery where the neurosurgeons need to manipulate a thin membrane before removing the tumor. Further down the road, decreasing the size of each robotic arm will bring new possible types of surgery to many people around the world. Therefore, my research in robotics-assisted telesurgery system will be a great foundation for future telesurgery research at Tufts. However, to be realistic with the given time in two summers, the system will be simplified to only perform the first steps of MSCIS, with a minimal set of instruments.

Originally, this surgical robotics system was only a side project that I kept in mind for three years. However, due to the COVID-19 pandemic, I never had the chance to start it during my first year at Tufts. Therefore, I came to Professor Intriligator at the beginning of 2021 and proposed my brain-child as a research platform, with the hope that it can jumpstart more research projects that lies between Mechanical and Biomedical Engineering at Tufts. He agreed to provide his full support on the research and introduced me to the Laidlaw Research and Leadership Program. As a Mechanical Engineering major with a Computer Science minor, I believe I'm qualified to design a proof-of-concept prototype given my previous experience with creating a mechatronics system from scratch with minimal funding. I have participated in the FIRST Robotics Competition for all four years of high school and continue this passion with Tufts Robotics Club. Not only inside college-level courses, but I also excel in a professional

workspace. Under the supervision of Tufts Technology Services (TTS) VP and CIO, I lead a team of undergraduates to create hardware solutions to automate processes at Tufts COVID-19 testing centers. I plan to reach out to the many faculties at Tufts to not only learn from their knowledge in the respective fields but also tight-knit relationships to connect possible opportunities where positive changes can be created at and for the Tufts communities.

As a continuation of this concept, I seek support from the Laidlaw Program to elevate a side-project into a recognized research experience. Due to the current limitations at Tufts given the COVID-19 pandemic, I'm the only one who can commit to the design & fabrication processes of the project. But holding a clear vision of this research, I will deliver the final product and demonstration by the end of summer 2022, and the Laidlaw Program can greatly support me in translating conceptual designs into tangible objects that can spark positive changes. Combined with my work ethic with a passion for surgical robotics research, as well as my robotics and mechanical engineering background, I believe I'm qualified to lead the project through its completion.