

FACULTY MENTOR Yip, Michael

PROJECT TITLE Haptics for minimally invasive robotic surgery

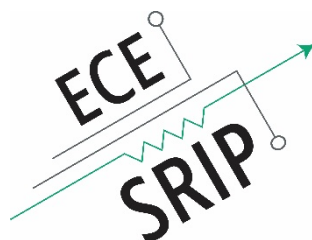
PROJECT DESCRIPTION

Robot-assisted laparoscopic surgery has shown promise in improving the performance of surgical procedures. However, one of the disadvantages of using such surgical systems is the lack of haptic feedback. Surgeons operating on teleoperated surgical robots rely heavily on imaging to estimate the interactive forces of the tool with the environment. Consequently, this poses limitation on the precision and safety of tissue interactions in complex surgical procedures. Providing haptic feedback to surgeons will enable surgeons to gain a better sense of tissue interactions, thereby improving the accuracy of surgery and identification of pathological conditions, and reducing the learning curve for users of teleoperated surgical robots. Current haptic feedback methods for teleoperated surgical systems involve integrated force sensors that are difficult to miniaturize, non-sterilizable, non-versatile, delicate, and costly. The aim of this research is to develop a robust, economic force sensor which will be able to accurately measure the magnitude and direction of force.

INTERNS NEEDED 2 Undergrad Students

PREREQUISITES

None



FACULTY MENTOR Yip, Michael

PROJECT TITLE Learning robot locomotion via reinforcement learning

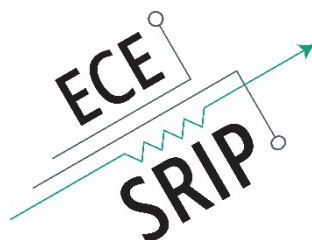
PROJECT DESCRIPTION

How do we, or any other animal, learn to locomote? If we encounter new environments (rough terrain, slopes, underwater), what strategies do we employ to learn quickly the best (maybe optimal) pattern to generate forward motion? Potential solutions that answer this question have been recently an extremely sought-after in the field of artificial intelligence and robotics. These strategies can be then employed on physical systems from legged robots to quadrupeds, from snake-like robots to flying systems. Recent machine learning research has taken inspiration from nature. Algorithms in reinforcement learning, neural networks, and genetic algorithms can learn how to perform tasks given time and experience, without user input. In this project, the team will be working to make a robot (snake-like robot) move in various terrains. The challenge for this project is that when working with robot systems in uncertain environments, you rarely have complete knowledge of how your robot and environment will react. Thus, techniques that employ a large amount of data (generated through simulation or through trials) are generally not a feasible option. In fact, the method must be able to work "online" -- that is, while it can do some simulation before making an attempt to move, it cannot be given a repository of successful or failed trials except those that it generates itself.

INTERNS NEEDED 2 MS Students OR 2 Undergrad Students

PREREQUISITES

Students will work on reinforcement learning algorithms in a simulated environment; those with significant CS background are strongly preferred.



FACULTY MENTOR Yip, Michael

PROJECT TITLE MRI-safe robot design and image-based control

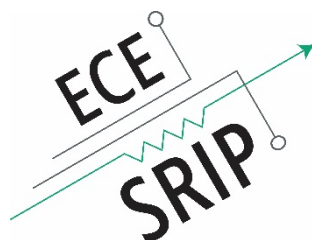
PROJECT DESCRIPTION

In this project, we will design an MRI-safe robot for needle biopsies. The robot will be constructed from MRI-safe materials, sensors and actuators. A crucial challenge is to make the robot fit inside the bore of an MRI machine while a patient is inside, resulting in often only a few cm of clearance. The proposed robot will be of a snake-like construction with a biopsy needle at its tip which is steered using real-time imaging. The imaging used will be real-time (MRI) as a means to hit target lesions to test for neoplasms, and has broad application to breast, lung, liver, and colon cancer.

INTERNS NEEDED 2 MS Students

PREREQUISITES

Students who have previously done substantial classes and projects in CAD, machine learning and computer vision are strongly preferred.



FACULTY MENTOR Yip, Michael

PROJECT TITLE Reducing tumor resection margins via natural medical image overlays through wireless augmented reality headsets

PROJECT DESCRIPTION

While augmented reality in surgery as a concept is not new, the lack of capable hardware and software had hindered its realization in practice. With the first untethered augmented reality headset by Microsoft made commercially available in 2016, hardware has finally reached the capabilities to provide compelling, and comfortable augmenting surgical visualization. This hardware not only improves spatial reasoning between tools and tissues inside the body in a natural manner but also provides an interface for registering medical images to visualize subsurface lesions in real-time to show tumor boundaries. Software for new, capable hardware systems is now required to meet the demands of compelling visual augmentation: high framerate, fine detail visuals of registered preoperative MRI/CT scans, with correct perspectives at all times. Our objective is to develop the necessary algorithms for real-time image registrations via augmented reality (AR) headsets and evaluate improvements to resection margins that would spare healthy organ function. We hypothesize that real-time image registration through untethered augmented reality headsets will improve visualization of subsurface tumor boundaries, improve regulation and consistency of resection margins, and consequently spare healthy tissue function. We will do so by relaying image registration and overlays of laparoscopic scenes wirelessly, and in real-time, to head-mounted displays, and evaluate surgical improvements from image overlay in a user study on a clinically-relevant laparoscopic simulator.

INTERNS NEEDED 1 MS Student OR 1 Undergrad Student

PREREQUISITES

Students need to have strong C++ programming experience, and have taken Computer Vision class(es). Image Processing and Computer Graphics are also desirable.

