FACULTY MENTOR
Yip, Michael

PROJECT TITLE
Development of a Surgical Robot's User Interface

PROJECT DESCRIPTION
This project involves the development of a user interface for a custom MRI and CT compatible needle-manipulation surgical robot. This project has two sub-components:

a)Robot "Master side manipulator" control development using a Phantom Omni (a force feedback robotic arm) to provide guidance to the physician. This device can allow the user to feel "forces" the robot encounters, whether real or simulated.

b) Smart Graphical User Interface (GUI) development incorporating responsive 3D imaging updates and overlays. This GUI will need to interpret the images and display the results to the user in an intuitive way.
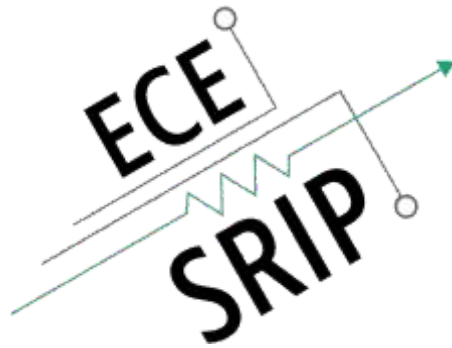
Will accommodate either in person or remotely.

INTERNS NEEDED
4 Students

PREREQUISITES
Experience with 3D graphics, GUI development, Python and/or C++, Robot Operating System, and Robotics.

FACULTY MENTOR
Yip, Michael

PROJECT TITLE
State estimation for autonomous suturing

PROJECT DESCRIPTION
Goal: Develop robust detection and tracking methods for objects in surgical environments, such as surgical needles and suture threads. The student will try to implement several tracking algorithms and develop new methods for better performance in a complex environment.
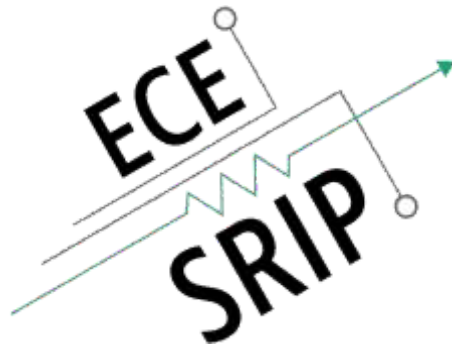
This project will be remote.

INTERNS NEEDED
1 Student

PREREQUISITES
Python or C++

FACULTY MENTOR
Yip, Michael

PROJECT TITLE
Planning in the constrained bimanual end-effector space

PROJECT DESCRIPTION
Goal: Develop planning algorithms for a bimanual robot in the low-dimensional end-effector space. The student will learn how to formulate a planning problem in the end-effector space and develop algorithms for bimanual planning in that space.
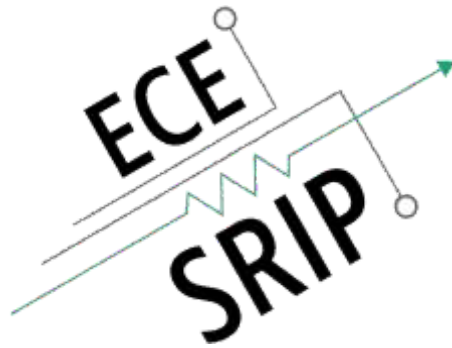
This project will be remote.

INTERNS NEEDED
1 Student

PREREQUISITES
Python

FACULTY MENTOR
Yip, Michael

PROJECT TITLE
Data efficient learning algorithms for learning from demonstrations

PROJECT DESCRIPTION
Goal: Develop more efficient learning algorithms that incorporate demonstrations. The student will compare different algorithms based on imitation learning, reinforcement learning, etc., observe their limitations in the real-world environment, and improve them.
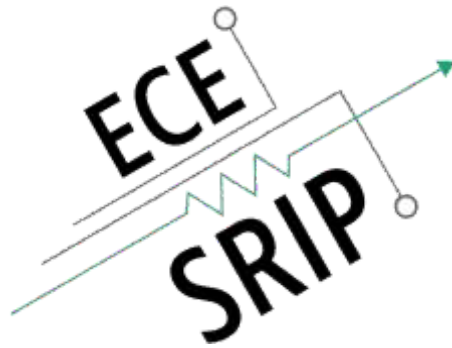
This project will be remote.

INTERNS NEEDED
1 Student

PREREQUISITES
Python; Tensorflow or Pytorch; imitation learning and reinforcement learning.

FACULTY MENTOR
Yip, Michael

PROJECT TITLE
Real-to-sim Control and Learning for Automation in Surgical Manipulation

PROJECT DESCRIPTION
It is difficult for autonomous manipulation of deformable tissue in surgical robotics, due to the lacking of models and properties of tissue. Taking the advantage of the simulation, one can track the robot-tissue interactions which can be useful for control and planning in real experimental setups. Physical simulation has been studied in the past decades and can be divided into mesh-based and mesh-free methods. However, it cannot be directly employed in real robotic tasks regarding the mismatch between the perception (such as images, point cloud, etc.) and simulation data. The goal is to develop a real-to-sim framework for interleaving perception, control, and learning approaches that generate optimal autonomous manipulation plans. The physical accuracy, computational stability, and real-time performance should be evaluated for the proposed approaches. It should break down the problems by 1) building a physical simulation environment for deformable tissues, 2) bridging the visual perception and simulation through registration and data transfer, 3) proposing simulation-in-loop controller using model-based or model-free methods, 4) investigating learning-based approaches to explore automation of sub-tasks (such as tensioning, grasping, etc.) in surgical manipulation.
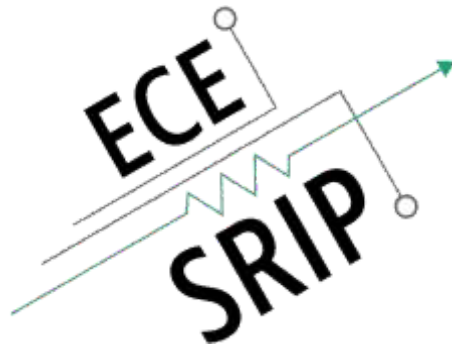
This project will accommodate either in person or remotely.

INTERNS NEEDED
4 Students

PREREQUISITES
MS. Knowledge of robotics. Good programming skills with Python/C++/Matlab

FACULTY MENTOR
Yip, Michael

PROJECT TITLE
Data-driven Approaches for Modeling and Control of Catheter Like Continuum Robots

PROJECT DESCRIPTION
The catheter like continuum robots can adaptively interact with the environment due to their continuously deformable and compliant nature. It has been intensively used for many surgical applications such as endoscopy procedures. However, the high dimensional nature renders under-actuated of this kind of robot. Meanwhile, the unpredictable uncertainties (such as frictions, hysteresis) result in modeling and control more challenging. There have been many advances in soft sensor technologies (such as shape, force) in the literature. However, it is difficult to deploy normal sensors into the catheter-like robots which their diameters are usually at the millimeter level. Instead of solely relying on body-integrated sensors on the continuum shape robots, the data-driven algorithms that extract information from online or offline experimental setups can benefit the improvements of accuracy. It can be viewed as characterizing and identification of system behavior. The objective is to 1) develop algorithms combining model-based with data-driven (machine learning) techniques for modeling of kinematics and dynamics, 2) propose online real-time controller dealing with uncertainties and disturbances (such as external contacts).

This project will accommodate either in person or remotely.

INTERNS NEEDED
2 Students

PREREQUISITES
MS or Undergraduate. Knowledge of AI/machine learning approaches. Good programming skills with Python.