Continuum Robot Modeling, Sensing, and Control for Enabling Complementary Situational Awareness

Interaction and perception capabilities supporting situational awareness

For robots to characterize unknown environments and to assist users during telemanipulation, we require robots with:

- Force sensing
- Contact detection
- Force/motion control
- Compliant motion control

Hybrid Force/Position Control of Continuum Robots

We present a new approach for hybrid force/position control framework including:

- Force control based on intrinsic force sensing
- Actuation compensation \( v_c \) for actuation lines
- Consistent motion and force control using configuration space stiffness of continuum robot

New Force Sensing Strategies for Continuum Robots

We are enabling the use of continuum robots that are usable in clinical environments to sense forces more accurately by compensating for frictional effects and investigating of sensing capability variations in varied robot and environment interaction configurations

- Intrinsic force sensing in continuum robot design
- Friction compensation across robot workspace
- Improved force-controlled manipulation in flexible environments

Intrinsic Friction and Compliance Parameter Estimation

Estimated model parameters to compensate for actuation conduit friction, backbone compliance, and motion hysteresis losses

Calibration – Enabling Accurate Autonomous Control

Motivation (Error Sources)

- Enabling semi-automated execution of tasks requires accurate robot motion
- Very high repeatability but poor precision if not directly controlled by user
- Assembly/material uncertainties

Study goals:

- Modeling framework capturing shape variations and twisting
- Investigate calibration error sensitivity

Dynamic Wrench Estimation in Continuum Robots

Motivation: To sense forces during dynamic interaction with the environment a wrench estimation method is needed. Prior methods assume quasistatic conditions.

Study goals: To evaluate the effect of dynamic forces on wrench estimation and to provide insights about design parameters affecting wrench sensing.

References: