Learning the Complete Shape of Concentric Tube Robots

Armaan Sethi

Concentric tube robots, composed of nested pre-curved tubes, have the potential to perform minimally invasive surgery at difficult-to-reach sites in the human body. In order to plan motions that safely perform surgeries in constrained spaces that require avoiding sensitive structures, the ability to accurately estimate the entire shape of the robot is needed. Many state-of-the-art physics-based shape models are unable to account for complex physical phenomena and subsequently are less accurate than is required for safe surgery. In this work, we present a learned model that can estimate the entire shape of a concentric tube robot. The learned model is based on a deep neural network that is trained using a mixture of simulated and physical data. We evaluate multiple network architectures and demonstrate the model's ability to compute the full shape of a concentric tube robot with high accuracy. We are then able to use the full shape of a concentric tube robot in a motion planner.