A Novel Controller for Soft Robots: An Experimental Usage of Linear Temporal Logic Mission Planning (LTLMoP) with an Optimized Elastomeric Actuator

Braunstein, Simone

This hybrid elastomeric robot successfully demonstrated that a synthesized high-level robot controller, Linear Temporal Logic MissiOn Planning (LTLMoP), can reduce the unpredictability of soft robots. Applications for soft robots include: search-and-rescue operations in extreme weather; versatile grippers which handle irregularly shaped objects; soft exosuits (wearable robots); and co-robotic assistive home health care for injury rehabilitation. Soft robots are typically made of elastomers, have no rigid structural elements, and are precisely designed to allow non-linear pneumatic actuation into complex geometric shapes. Currently, soft robots' non-linear actuation is difficult to predict because their movements have many degrees of freedom. Verifiable, synthesized high-level control systems exist for hard robots, but have never been previously employed with soft robots. The LTLMoP toolkit is a collection of Python applications employing a sensor-based continuous-controller framework to guarantee that the robot will complete a task, if that task is feasible. This three-part experiment optimized a soft robotic gripper (actuated by a calibrated system of pneumatic channels), designed the first electro-pneumatic control system to be used with LTLMoP, and successfully controlled the hybrid robot's grasp and motion across a map of five regions, monitored by the Vicon 3D Motion Capture system. The synthesized LTLMoP controller monitored the soft robot's location and adjusted its behavior to generate a guaranteed outcome. This interdisciplinary robotics experiment combined mechanical engineering, material science, electrical engineering and computer programming, to enable subsequent soft robots to outperform traditional hard robots in certain tasks.

Awards Won:

Second Award of $2,000