

# 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