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Abstract

Self-Sensing, Compliant, and Large-Strain Twisted String Actuators

Robotic artificial muscles are alternatives to electric motors; they have advantages comparable to human skeletal muscle. Twisted string actuators (TSAs) are artificial muscles with high efficiency, strain, and force output. In a TSA, a motor twists a pair strings, which shortens their length to create linear actuation. Typically, stiff strings are utilized for high force output. However, compliant strings with low stiffness can make robots safer during human-robot interaction. In this study, TSAs are fabricated from twisted and coiled strings, known as supercoiled polymers (SCPs). The SCPs are made from silver-coated nylon threads. SCPs have three main advantages, the first being that they have low stiffness. In addition, they are commonly used as actuators which contract under applied heat. Thirdly, because they are conductive, their electrical resistance changes significantly with its length, enabling self-sensing TSAs. Previous studies on TSAs with compliant strings encountered a significant decrease in maximum strain over TSAs with rigid strings. In this study, compliant TSAs actuated by heat and motor rotations achieve over 30% maximum strain, which is typical of rigid TSAs. In addition, clear correlations are demonstrated between resistance and length for self-sensing. Finally, the compliant TSAs are also applied to a three-fingered robotic gripper.