Model-based Performance Analysis of Twisted String Actuators with Application to Wearable Assistive and Resistive Exo-gloves

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As an emerging compliant actuation mechanism, twisted string actuators (TSAs) efficiently generate linear contraction by twisting strings with a motor to shorten the strings' length. Compared to other actuators, TSAs possess unique advantages, such as simplicity of construction, large force outputs, and high energy efficiency. TSAs have shown strong potential to drive a variety of robots. However, few studies have been conducted to investigate the performance limits of TSAs, which makes it difficult to understand the trade-offs of TSAs. First, we will present a systematic model-based performance analysis of TSAs with a focus on four metrics: contraction range, linear velocity, effective torque input, and force output. The results show that TSA can produce larger force with a small and lightweight motor. Second, taking advantage of TSA's large force capability, we present an active wearable assistive and resistance device (AWARD). AWARD is a wearable robotic glove capable of producing assistance and resistance to the motion of fingers, which could physically augment astronauts with demanding tasks or resist them as an exercise machine in space.