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Analytical Modeling and Evaluation of Curvature-Dependent Distributed Friction Force in Tendon-Driven Continuum Manipulators

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Tendon-Driven Continuum Manipulators (TD-CMs) have gained increasing popularity in various minimally invasive surgical robotic applications. However, the adverse effects of tendon-sheath friction along the transmission path may result in significant non-uniform cable tension and subsequently motion losses, which affects the deformation behavior of a TD-CM. Most of the current approaches for modeling friction have been mainly developed based on either simplifying assumptions (e.g., constant-curvature deformation behavior or point load friction forces) or experimentally-tuned lumped models that are not extendable to a generic deformation behavior for a VC-CM. We propose developing a physics-based modeling approach for modeling deformation behavior of a TD-CM by extending the typical geometrically exact model based on the Cosserat rod theory and include the effect of Curvature-Dependent Distributed Friction Force (CDDF) between the tendon and sheath.

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