

Paper Title:

Chained Spatial Beam Constraint Model: A General Kinetostatic Model for Tendon-Driven Continuum Robots.

Authors:

Yuhan Chen; Shilong Yao; Max Q.-H. Meng and Li Liu*

Abstract:

The profile estimation for continuum robots is a crucial problem concerning automatically controlling robots. The conventional method is based on the Cosserat rod theory, which is limited by the dependence of the convergence on the initial guess and computational complexity. To tackle these issues, this article proposes a general kinetostatic model to estimate the profile of the tendon-driven continuum robot (TDCR). We first abstract the backbone of the TDCR as an Euler–Bernoulli beam and then derive the spatial beam constraint model of a circular cross-section beam without considering torsion and shear. Next, taking a single-section TDCR as an example, we provide comprehensive modeling, considering the driving tendon tensions, friction, gravity, and external forces. Subsequently, an algorithm based on the chained spatial beam constraint model is proposed to estimate the robot's profile. The method can be generalized to the TDCR with different configurations. Simulations demonstrate the accuracy, computational efficiency, and computational success rate of our method, as well as its advantages over the state-of-the-art. Real-world experiments have also been performed to validate the effectiveness of our method with three different configurations of the TDCR.

Link:

<https://ieeexplore.ieee.org/document/10403537>

Citation:

Y. Chen, S. Yao, M. Q. . -H. Meng and L. Liu, "Chained Spatial Beam Constraint Model: A General Kinetostatic Model for Tendon-Driven Continuum Robots," in IEEE/ASME Transactions on Mechatronics, doi: 10.1109/TMECH.2023.3348510.