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Dynamic Modeling of a Spatial Cable-Driven Continuum Robot Using Euler-Lagrange Method

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Abstract

Continuum robots are kinematically redundant and their dynamic models are highly nonlinear. This study aims to overcome this difficulty by presenting a more practical dynamic model of a certain class of continuum robots called cable-driven continuum robot (CDCR). Firstly, the structural design of a CDCR with two rotational degrees of freedom (DOF) is introduced. Then, the kinematic models are derived according to the constant curvature assumption. Considering the complexity of the kinetic energy expression, it has been approximated by the well-known Taylor expansions. This case corresponds to weak bending angles within the specified bending angle range of the robot. On the other hand, due to the low weight of the CDCR components, the gravitational energy effects can be neglected compared to those stemmed from the elastic energy. Thereafter, the corresponding dynamic model is established using Euler-Lagrange method. Static and dynamic models have been illustrated by examples. This analysis and dynamic model development have been compared with the existing scientific literature. The obtained results shown that the consistency and the efficiency of accuracy for real-time have been carried out. However, the dynamic modeling of CDCR with more than 2-DOF leads to a more complex mathematical expression, and cannot be simplified by adopting the similar assumptions and methodology used in the case of 2-DOF.

Keywords: continuum robot, cable-driven continuum robot, Taylor expansions approximations, Euler-Lagrange method, dynamic modeling

1References

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