



A pre-strained flexoelectric rod theory for soft robotic grippers

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Soft robotic grippers have shown significant potential in minimally invasive surgery, agriculture, and other industrial applications. For the first time, we showcase the underlying mechanism of flexoelectric soft robotic grippers that operate under open- and closed-circuit conditions. Flexoelectricity is present in all dielectric materials (both centrosymmetric and non-centrosymmetric) in such a way that the strain gradient tensor and polarization vector are related through a fourth-order flexoelectric tensor. To understand the gripping mechanism of the flexoelectric soft gripper, we first formulate a flexoelectric special Cosserat rod theory that incorporates intrinsic strains such as intrinsic flexural strain, intrinsic twist, etc. Subsequently, we establish constitutive relations and identify correct effective strain measures through work conjugate. We finally highlight the capabilities of flexoelectric grippers across different flexoelectric coefficient values and identify the gripping and non-gripping zones. On the one hand, the electric fields generated in the flexoelectric gripper under open-circuit conditions provide optimized force-feedback control to grip and prevent excessive localized damage to the object. On the other hand, the voltages directly provide optimized force-feedback control under closed-circuit conditions to grip and to prevent localized damage. In general, the overall gripping mechanism has been enhanced when the flexoelectric gripper is considered as intrinsically curved.

Prakhar Gupta is currently an Assistant Professor at the Department of Mechanical and Aerospace Engineering, IIT Hyderabad. He is currently working in the areas of gradient theories, flexoelectricity, chemoelasticity, magnetic bead assemblies, soft robotics, toy mechanics, and architected materials.

<https://sites.google.com/site/iitdprakhargupta>

The seminar is organized by the Solid and Structural Mechanics Group [D. Bigoni, F. Dal Corso, L. Deseri, D. Misseroni, M.F. Pantano, A. Piccolroaz, N. Pugno, R. Springhetti]