Design and Optimization of Large-Deformation Compliant Mechanisms

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As compared to conventional mechanisms, compliant mechanisms exploit flexible deformation rather than rigid body motion of its components. The key advantage of jointless structures lies in the absence of relative motion between the links. Besides the reduction in parts required to perform a task, compliant mechanisms typically show little friction, if any, and do not require lubrication to minimize wear. On the downside, design and synthesis of compliant mechanisms becomes more involved than with rigid-body linkages. In particular, optimization of compliant mechanisms relying on (sub-)structures subjected to large flexible deformation is a challenging task, in which several, possibly conflicting aspects need to be considered. First and foremost, kinematic analysis of compliant mechanisms usually requires geometric non-linear to be accounted for. Further, limitations in actuation forces and torques impose constraints on the design. Depending on the application, the performance of compliant mechanisms may crucially depend on the natural frequencies and their change over the range of operation. In view of the diverse aspects, we typically have to deal with multi-objective optimization problems in comparatively high-dimensional parameter spaces. In the present paper, we outline our approach for the design of compliant mechanisms based on flexible multibody systems and evolutionary optimization.