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Dynamic modeling of a rolling tensegrity structure with spatially curved members

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Abstract: Tensegrity Structures were recently accessed in the field of engineering due to their advantageous properties like shock resistance and shape changeability. Especially, in (soft) robotics, the application of those structures is a promising approach. Various types of locomotion can be realized using tensegrity structures. Here, a rolling locomotion system based on a tensegrity structure with precurved members is presented. The rolling locomotion is initialized by varying the center of mass due to shifting an internal mass. Furthermore, a proper shape change is applied to steer on a horizontal plane. The locomotion system is modeled as a multibody system and the corresponding non-holonomic dynamics are derived. Simulations considering the locomotion behavior are performed for various actuation strategies and mechanical parameters. Based on these results a reliable actuation strategy to maneuver in two dimensions by pure rolling is derived. Furthermore, recommendations regarding the constructive development of a real prototype based on a tensegrity structure are given.

Keywords: Compliant tensegrity structure, non-holonomic constraints, dynamics