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Università degli Studi di Pavia
Computational Mechanics & Advanced Materials Group - DICAr

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Virtual Modeling and Additive Manufacturing for Advanced Materials

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Data-Driven Modelling of Isotropic and Anisotropic Hyperelastic Solids

Data driven hyperelasticity is a promising approach for the constitutive modeling of rubberlike materials, soft biological tissues and biocompatible soft polymers. It enables direct use of experimental data for the construction of the stress-strain response without need of a specific analytical expression for the strain energy density function. Considering the variations in tissue architecture, e.g. fiber content, fiber density distribution and distinct material response of the constituents of the tissue, it is not possible to model all types of tisses with a single mathematical form. The same applies to 3D-printed artificial tissues. In this study, we propose distinct kinematic approaches to hyperelastic response of rubberlike materials, e.g. invariant, principal stretch based formulations, respectively. The partial derivatives of the strain energy density functions are replaced with appropriate B-spline interpolations with a set of control points are implemented for various multiaxial loading scenarios such as uniaxial tension, pure shear, and (equi)biaxial tension deformations. In addition, the convexity requirement is enforced into the spline interpolation in order to ensure a convex and stable constitutive response. The data sets of Treloar and Kawabata are used in order to demonstrate the performance of the the proposed data driven approach. The same approach is extended to a dispersion-type anisotropic constitutive framework for the modelling of soft biological tissues. The results of the proposed approach are compared to the well known constitutive approaches with regard to ex vivo stress-strain curves from various tissues.

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