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MODEL ORDER REDUCTION APPLIED TO GEOMETRIC NON-LINEAR MULTISCALE MODELING

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Abstract. The goal of this work is to present a novel reduced-order model based on the Proper Orthogonal Decomposition (POD) and a reduced goal-oriented integration rule, applied to materials that exhibits a clear non-linear geometrical behavior, these two strategies work together in order to reduce considerably the computational cost, widely known in multiscale modeling via computational homogenization. The geometrical non-linear behavior is modeled via constitutive hyperelastic J2 plasticity model. To take into account the mechanical behavior at the microscale level, a representative volume element (RVE) is composed by a sort of randomly distributed voids spreaded within a matrix, follows an isotropic elastic-plastic behavior representing metal alloys and other ductile materials. This methodology can be extended to materials composed by several constituents following different material behaviors. This reduced order model is composed by two stages, the first one, called "off-line" stage, is devoted to compute the input entities for the second stage, for doing that, the high-fidelity (HF) version of the boundary value problem at the small is solved for a set of representative strain trajectories, taking snapshots (pseudo-time discrete solutions) of the microscale strain fluctuations field and its corresponding Helmholtz free energy, with this set of snapshots, and using a SVD-like procedure, the projection operators are computed. In the second stage, also called "online" stage, the high-fidelity problem is projected and integrated using the projection operators and the reduced integration rule previously computed. The reduction of these two primal variables (micro strain fluctuations and Helmholtz free energy) work simultaneously in order to reduce the model complexity guaranteeing consistency with small errors and good accuracy.