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PGD BASED MODEL REDUCTION OF UPDATED-LAGRANGIAN MESHLESS DISCRETIZATION

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Numerical simulation plays a key role in the development of new advanced manufacturing processes and the optimization of existing ones. Nowadays is a real challenge to perform these simulations without simplifying the physics in a reasonable computational cost to industry. Mainly this is because of the multiphysics nature, the presence of nonlinearities, or large deformations inherent to these processes such as material forming, automated tape placement or Friction Stir Welding (FSW).

Simulations inspired in CFD have been used extensively in the literature even when an Eulerian approach has severe limitations to consider the appearance of defects, residual stresses, evolution of free surfaces or variable boundary conditions. By contrast, Lagrangian formulations allow the possibility to track the history of material particles, free surfaces and complex boundary conditions imposed on unconfined flows. Unfortunately, the large deformations associated with these processes lead to the rapid distortion of the mesh, being necessary to carry out updated-Lagrangian algorithms with expensive and complex remeshing techniques also introducing numerical diffusion. ALE formulations have managed to combine the advantages of both approaches leading to accurate results [1]. More recently, the goodness of meshless methods for the simulation of these processes has been shown, having the advantages of an updated-Lagrangian method without the drawback of mesh distorsion [2]. Nevertheless, 3D simulations are still very expensive with these techniques.

To overcome this, in this paper we propose an original numerical approach coupling a 3D meshless framework with Proper Generalized Decomposition (PGD). The main ingredients are a natural element discretization (NEM), insensitive to the deformation of the mesh, and PGD as a Reduced Order Model technique which allows through the separation of variables in-plane-out-of-plain, to obtain 3D precision results with a 2D computational cost [3].

The feasibility of this proposed method is analyzed with a thermomechanical benchmark problem with Newtonian fluid and with a generalized Newtonian fluid, analyzing different routes for performing model reduction within an updated Lagragian framework.

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