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A novel non-linear ROM strategy for steady-state elastohydrodynamic line contact problems and its applicability to lubricated contact in multibody

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Gears and roller-bearings are among the most used components in transmissions, powertrains and machines in general. They are used to transfer power and motion thanks to multiple non-conformal contact interactions. These usually happen at specific locations such as gear teeth and between rollers and raceways. In many applications, a lubricant is also employed to satisfy requirements such as durability, NVH, cooling, etc… The typical operating conditions – e.g., loading and speed – of lubricated contact makes them work in the elastohydrodynamic (EHL) regime. In this regime both the stiffness of the solids and that of the lubricant play a significant role. Moreover, the lubricant behavior varies significantly depending on the relative motion and load at the contact location. While these local contact interactions are of paramount importance due to the localized high pressures and stresses, they are also coupled to the global dynamics of the machines they are mounted on.

In terms of CAE prediction methodologies, EHL contact can be simulated with methods ranging from simple analytical solutions up to Navier-Stokes Equations while mechanism can be simulated with rigid or flexible multibody models. While analytical models can be solved relatively fast, higher levels of fidelity are generally computationally not affordable despite the higher accuracy when taken in a system-level context within multibody dynamics simulations. This work combines the discretized Boussinesq and Reynolds equations and proposes a novel MOR approach for steady-state EHL contacts that aims at reducing the dimensionality of the underlying full-order EHL problem [1]. The method combines a Petrov-Galerkin approach for the structural part with a new non-linear hyper-reduction scheme that takes inspiration from the DEIM approach [2] for the fluid domain. Two phases are distinguished: An offline phase where the reduction spaces are automatically defined by means of a selective refinement technique and an online phase where the reduced order model solution is computed. The ROM is then compared against the full order model in terms of accuracy and speed. The method shows an excellent accuracy for the predicted pressure and fluid film thickness while drastically reducing the model dimensionality and computational burden.

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