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An efficient hybrid approach to gear contact simulation in multibody systems leveraging reduced order models

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Computational methods applied to contact mechanics have a long history. The span of available algorithms ranges from simplified penalty approaches between rigid bodies to highly refined non-smooth discrete methods based on non-linear finite elements.
Multibody dynamics schemes position themselves in a broad application field of computational mechanics. Namely they are usually useful to efficiently solve systems with a small/medium amount of degrees of freedoms while being computationally efficient and retaining a fair accuracy level.
Drivetrain powertrains and gearboxes are often simulated with (flexible) multibody techniques due to the importance that they have in the system-level dynamics performances. Within such systems, the contact interactions between different gear stages are of paramount importance to predict, e.g., the NVH behaviour of the full machine assemblies to which the gearbox is connected (vehicles, wind turbines, airplanes, etc.).
The multibody research team of Siemens Industry Software NV has put considerable effort in revisiting their numerical approach to drivetrain simulations. Geometrical effects such as misalignment and microgeometry modifications are taken into account thanks to a tailored contact detection scheme. In order to efficiently solve the contact problem, a non-linear complementarity problem is regularized with a stable Newton scheme and accounts for local non-linear Hertzian phenomena and linear flexibility of the gear bodies [1] including coupling between multiple contacting teeth and lightweight gear bodies [3]. This is efficiently attained thanks to notions closely related to the field of discontinuous model order reduction [2,3]. Experimental and numerical comparisons are proposed to validate the quality of the proposed approach.

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