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Dictionary based approximations for reduced order models in contact mechanics

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In various engineering applications, there is a necessity of real-time simulations to accelerate decision-making or design optimization processes. Real-time contact mechanics simulations might have a significant impact is the non-conformance management in the production of engineering structures and their parts. In a manufacturing setup, efficient reduced order models for contact problems have the potential to perform fast simulations of non-conforming structures; thereby accelerating the decision-making process.

However, the reduced order modelling of contact mechanics is relatively recent and is an evolving domain. Apart from the natural difficulties of contact mechanics like contact detection and solving an inequality-constrained problem, other challenges appear due to the local nature of contact. Current approaches typically use mixed methods with reduced bases for displacement and contact pressure, the latter with non-negative properties [1, 2].

For a contact problem with a significant change in contact position, the contact pressure field can be shown to be irreducible. Consequently, it is difficult to estimate the contact pressure and area accurately in a reduced framework. Dictionary methods with a large training set are proposed as a mitigatory framework in this context. The dictionary-based approximation problems are projected on a low-dimensional basis (for e.g. Randomized sketching methods [3]) whose computational complexity does not change significantly with the size of dictionaries are used. Lastly, perspectives on using non-linear dimensionality reduction methods to overcome the irreducibility of contact pressure are discussed.

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