# An objective and path-independent large rotation shell formulation

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## ABSTRACT

Development of geometrically exact, non-linear shell formulations for large rotations has been subject to intensive research for several decades. A lot of progress has been made and many issues are well understood today, but there are also still some open questions. Many existing formulations suffer from singularities due to the non-linear space of the unit sphere. Additionally, some of the existing models proved to be non-objective and provide path dependent results. For one dimensional spatial rod finite elements these problems have been solved by Crisfield and Jelenic [1]. For shell models with Reissner-Mindlin kinematics, however, they seem to persist.

We present an efficient, objective, singularity-free and path independent non-linear Mindlin-Reissner shell formulation for both standard and isogeometric finite elements. In particular, this formulation utilizes the ideas on *geometric finite elements* presented by Sander [2] and subsequent papers. Due to the fact that the nodal directors live on the unit sphere, a special linearization procedure is required. Here, we use the simple construction of Absil et al [3], which yields a direct way to obtain the correct tangent operator for a static solution procedure. Path independency and efficiency of the formulation are verified via a set of numerical examples.

## REFERENCES

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[3] Absil, P. -A. and Mahony, Robert and Trumpf, Jochen, *Optimization Algorithms on Matrix Manifolds* (2008)