Projective Geometric Elasticity

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Abstract

The coordinate description of lines of 3 dimensional projective space developed by Julius Plücker in the 1860's originates from the description of spatial force and inifinitesimal displacement systems. This was later extended with elastic beam theory and the description is actively used today, for instance in the deisgn of kinematic chains. The subject of the talk is the next step in the projective treatment of mechanics: describing how to treat continuum problems in the projective setting. We show how to embed the stress and infinitesimal strain tensor in projective line geometry and identify stress and strain states with generalized conics and quadrics. This opens up the possibility to take projective collineations (transformations that preserve point-line incidence but not parallelism) of elasticity problems advancing beyond the previously explored affine transformations. We show that many boundary conditions of elasticity problems are incidence conditions and thus are projective invariants. We show that material properties like isotropy or global orthotropy are not projective invariants. As such the talk concludes with the projective transfromations of membrane shells such that the correspondence of the shape and stress functions as established by Pucher's equation is preserved.

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