Isogeometric analysis and patchwise reproducing polynomial particle method for plates

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Abstract

Isogeometric analysis (IGA) is a framework bridging the gap between Computer Aided Design (CAD) and Finite Element Analysis (FEA). So it drastically reduces the error in the representation of the computational domain and the re-meshing by the use of "exact" CAD geometry directed at the coarsest level of discretization. This is achieved by using B-splines or Non-Uniform Rational B-Splines (NURBS). In order to handle the singularities arising in the PDEs, we construct a novel NURBS geometrical mapping that generates singular functions resembling the singularities. Also, we consider how to use the proposed mapping method in IGA of elliptic problems and elasticity containing singularities without changing the design mapping. For this end, the mapping method is used to enrich NURBS basis functions around a neighborhood of corner singularity so that they can capture the singular behavior of the solutions to be approximated. For a crack singularity, we cut out a singular zone including the crack tip by using Partition of Unity (PU) functions and paste back the image of the parameter space corresponding to the singular mapping proposed. Finally, Reproducing Polynomial Particle Method (RPPM) is one of meshless methods that use meshes minimally or do not use meshes at all. The RPPM is employed for free vibration and buckling of the first order shear deformation model, called the Reissner-Mindlin plate, and for analysis of boundary layer of the Reissner-Mindlin plate. Also, we demonstrate that our method is more effective than other existing methods in dealing with Reissner-Mindlin plates with various material properties and boundary conditions.

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