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The Natural Neighbour Radial Point Interpolation Method extended to the Non-Linear Analysis

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ABSTRACT

In this work it is presented the large deformation analysis of non-linear elastic structures based on the Natural Neighbour Radial Point Interpolation Method (NNRPIM) [1, 2], which is an improved meshless method.
The NNPRIM uses the Natural Neighbour [3] concept in order to enforce the nodal connectivity. Based on the Voronoï diagram [4] small cells are created from the unstructured set of nodes discretizing the problem domain, the “influence-cells”. These cells are in fact influence-domains entirely nodal dependent. The Delaunay triangles [5], which are the dual of the Voronoï cells, are used to create a node-depending background mesh used in the numerical integration of the NNRPIM interpolation functions. Unlike the FEM, where geometrical restrictions on elements are imposed for the convergence of the method, in the NNRPIM there are no such restrictions, which permits a random node distribution for the discretized problem. The NNRPIM interpolation functions, used in the Galerkin weak form, are constructed in a similar process to the Radial Point Interpolation Method (RPIM) [6, 7], with some differences that modify the method performance. In the construction of the NNRPIM interpolation functions no polynomial base is required and the used Radial Basis Function (RBF) [8] is the Multiquadric RBF. The NNRPIM interpolation functions posses the delta Kronecker property, which simplify the imposition of the natural and essential boundary conditions.
Once the scope of this work is to extend and validate the NNRPIM in the large-deformation elasto-plastic analysis, the used non-linear solution algorithm is the Newton-Rapson initial stiffness method [9] and the efficient “forward-Euler” procedure [10] is used in order to return the stress to the yield surface.
Several non-linear elasto-plasticity problems are studied to demonstrate the effectiveness of the method. The numerical results indicated that NNRPIM handles large material distortion effectively and provides an accurate solution under large deformation.

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