Manifold basis functions with sharp features for isogeometric analysis on unstructured meshes

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Manifold-based surface construction techniques are well known in geometric modelling and a number of variants exist. Common to all is the concept of constructing a smooth surface by blending together overlapping charts as in differential geometry description of manifolds. We combine manifold techniques with conformal parameterisations and the partition-of-unity method to derive finite element basis functions on unstructured quadrilateral meshes. Polynomials with prescribed degree and continuity are used as local approximants on each chart. Sharp features are represented with suitably chosen C^0-continuous local polynomials. As will be demonstrated, the new sharp basis functions have to be carefully constructed in order to be suitable for both geometric modelling and analysis. Finally, the integration of the manifold basis functions with b-spline surfaces with irregular vertices will be illustrated. Our numerical simulations indicate the optimal convergence of the obtained approximation scheme for Poisson problems and near optimal convergence for thin-plate and thin-shell problems discretised with unstructured quadrilateral meshes.