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STRAIN-GRADIENT CONTINUA WITH HIERARCHICAL REFINEMENT OF NURBS

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Isogeometric analysis is an extension of the finite element method where basis functions used for geometrical modelling are also used for analysis. NURBS is an example of a widely-used shape function in both geometrical modelling and isogeometric analysis. Due to its higher-order nature, it has found many applications in higher-order gradient models relevant for engineering materials [1], which exhibit size-dependent behaviour as observed from experiments. These models typically incorporate a length scale, which can be correlated with material properties at smaller scales, to capture size effects or even preserve a well-posed boundary value problem beyond the formation of a localisation band [2]. Sometimes in numerical analysis, accuracy necessitates a fine mesh close to certain geometrical features. However, maintaining a fine mesh globally can be overly expensive. The tensor product structure of NURBS which restricts local refinement compounds the problem. Hence, adaptive refinement of NURBS is an active area of research [3]. Computations using higher-order gradient models also stand to benefit from local refinement, for example, in resolving areas around localisation bands.

Mesh refinement strategies generally ensure efficient computations especially in problems with geometrical singularities, localisation and/or strong gradients. Herein, continuum theories with second-order strain-gradients are considered. Refinement is performed based on a multi-level mesh with element-wise hierarchical basis functions, which interact via a subdivision operator. This ensures a standard finite-element data structure. An error-based quantile marking is used to select elements for refinement. The capability of the implemented numerical procedure is demonstrated with two-dimensional examples.

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