Adaptive Control Volume Isogeometric Analysis for numerical modelling of engineering problems

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Many real applicative and industrial problems in computational mechanics have been solved by numerical simulations that require large computational resources including parallel processing and the use of CPU/GPU clusters. Therefore, it is of great importance that computer resources are used as efficiently as possible. The main objective of this work is to demonstrate the capabilities of spline basis functions through the development of novel numerical method with specific application to problems with highly localized steep gradients. Emphasis is given to Fup basis functions (see [1, 4]) as representative member of the spline family. Due to certain similar properties with classical IGA [2], used method is called control volume isogeometric analysis (CV-IGA) [3]. However, since classical isogeometric analysis mostly uses NURBS or B-spline basis functions in conjunction with the Galerkin or collocation formulation, here, the proposed model will be based on Fup basis functions and the control volumes formulation enabling local and global mass conservation, as well as approximate solutions of higher smoothness. Hierarchical Fup (HF) basis functions enables local hp-refinement which means that higher resolution levels have basis functions not only of smaller length of the compact support (h- refinement) but also contain basis functions of higher order (p-refinement). Thus, the method obtains spectral convergence properties, unlike uniform Fup_n and B_n basis functions which achieves the maximum theoretical polynomial convergence order of p = n + 1. Results show application to engineering problems achieving efficient adaptive grid and multiresolution description of all spatial and temporal scales [3, 4].

References

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