Exact representation of interfaces using Enriched Level-Set technique

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This work aims to improve implicit representation of complex industrial work-pieces by reducing the existing gap between Computer Aided Design (CAD) and Computer Aided Engineering (CAE). The proposed approach is based on the level-set technique [1]. Limitations of the latter technique results in the miss-capturing of corners lying on the interface (iso-0 level-set) and other sharp features. These limitations also have a significant impact on surrounding elements. In order to avoid undesired over-smoothing to the sharp features, especially corners, an enhanced representation is proposed that is based on level sets method is introduced. This technique, referred in what follows by level-set+ ,enriches the classical level-set by using data related to the corner points. This is done by automatically detecting geometrical points and using this information in the implicit representation. Elements containing these geometrical points and surrounding elements will be re-subdivided according to the updated iso-contour. This technique helps to employ classical level set and preserve current data structure for most of the creation of the iso-0 level set.

Although the method is general enough to handle most possible configurations in terms of the corner locations, there are still limitations which have been handled in such a way to prevent computational failure. Also, the technique is effective at reducing the memory requirements by automatically erasing sharp features that are no longer existing after e.g. boolean operations. Some novel results illustrates accurate implicit representations of boundaries including the exact capture of sharp features in 2D and 3D.

All the developments are implemented in our in-house finite element software Morfeo. There are numerous applications which can benefit from the above

mentioned developments including crack propagation with the X-FEM method
and transient machining simulations.