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Quality-controlled hybrid method for multi-body moving mesh simulations

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Abstract

The simulation of physical phenomena involving moving bodies undergoing large displacements represents a real challenge. These simulations, which combine the difficulties related to instability, meshing and Fluid-Structure Interaction, are generally difficult to perform and have a high computational cost.

In this work we propose an efficient "r-to-h" adaptation algorithm for moving boundaries problems using only vertex displacements and some local h-adaptation operations. Moving boundaries algorithms usually require the regeneration of the mesh to avoid his invalidation in particular when the motion is large and/or several bodies are involved. The proposed approach aims to move the mesh nodes, using the Inverse Distance Weighting (IDW) interpolation method [1–4], while conserving the mesh connectivity until the mesh elements quality deteriorates. At this point, a selective h-adaptation inspired from [5] involving local mesh modifications such as edge flipping, local refinement and local coarsening is performed only on the submeshes containing badly-shaped elements. The developed approach is valid for multi-body simulations and is able to handle their simultaneous independent displacements.
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Keywords: Moving meshes, Inverse Distance Weighting, h-adaptation, r-adaptation, submesh modification, mesh optimization

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