Special Program in Applied Mathematics and Applied Mechanics

A fast and robust hybrid method for block-structured mesh deformation with emphasis on FSI-LES applications

Prof. Shuvam Sen

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An efficient technique for the deformation of block-structured grids occurring in simulations of fluid-structure interaction (FSI) problems relying on large-eddy simulations (LES) is introduced. The proposed hybrid approach combines the advantages of the inverse distance weighting (IDW) interpolation with the simplicity and low computational effort of transfinite interpolations (TFI), while preserving the mesh quality in boundary layers. It is an improvement over the state-of-the-art currently in use. To reach this objective, in a first step three elementary mesh deformation methods (TFI, IDW and radial basis functions) are investigated based on several test cases of different complexities analyzing their capabilities but also their computational costs. That allows to point out the advantages of each method but also demonstrates their drawbacks. Based on these specific properties of the different methods, a hybrid methodology is suggested which splits the entire grid deformation into two steps: First the movement of the block-boundaries of the block-structured grid and second the deformation of each block of the grid. Both steps rely on different methodologies, which allows to work out the most appropriate method for each step leading to a reasonable compromise between the grid quality achieved and the computational effort required. Finally, a hybrid IDW-TFI methodology is suggested which best fits to the specific requirements of coupled FSI-LES applications. This hybrid procedure is then applied to a real-life FSI-LES case.

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