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Anisotropic adaptive body-fitted meshes for CFD

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The development of efficient methods to simulate multi-components systems is among engineering challenges and still a need for industrials, especially in the case of fluid-structure interaction or conjugate heat transfer. In this work, a new anisotropic adaptive body-fitted mesh method is proposed. Its simplicity and generality allow it to tackle complex geometries as well as complex physical simulations. Two successive iterations are combined: first, gradient-based metric construction uses the gradients of the Level-set function of any immersed object to generate an anisotropic well-adapted mesh [1]. This adaptation allows the mesh to be locally defined near its zero-value, passing the interface through the stretched elements. A second step is then required: it is based on R-adaptation and swapping [2], applied on the isolated cut elements to provide a sharp anisotropic fitted mesh. This new approach achieves the desired local geometry resolution of a body-fitted mesh and obtains the needed numerical accuracy at the interface due to the anisotropic unstructured. With the algorithm proposed, 2D and 3D parallel applications, as well as real-life practical problems, will be addressed to solve complex fluid-solid interactions and CFD problems, involving boundary layers, curvatures and high gradient solutions [3,4].

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