Grid deformation based on macro-element and partitioning techniques for flapping mechanism

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The grid deformation algorithms can be classified into linear algebra methods, elasticity-based approaches, and their hybrid forms. The methods in the first category have advantages in efficiency, but do not normally produce grids of sufficient quality. A spring analogy in the second category is known to cause grid irregularity for the large moving boundary problem and methods for improving the robustness of the grid regularity are subsequently required. The finite element method in the same category provides better quality than simple interpolation schemes, but become too expensive for large grids. Hybrid method using the macro-finite elements and interpolation reduced not only computational cost for finite element solution over entire grid, but also the disparity of mesh size, which causes bad effect on the grid quality.

However, the hybrid scheme is still needed to be improved for the flapping mechanism, which has the large deformation and motion. The failure during the grid deforming is mainly occurred near the moving object, namely the flapper. So the improvement should be focused on this region. Therefore, in this work, partitioning into body-fitted grid and other is enhanced on top of the hybrid scheme using the macro-element technique. In a little detail, the grid deformations are firstly computed in the body-fitted grid region because the highest performance is required. The deformations along the interface between the two regions are used as the boundary condition for the other domain. The hybrid scheme is then applied to the other region. The proposed grid deformation shows the better performance as compared to a conventional hybrid scheme in terms of grid orthogonality and its volume change..

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