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A MASS CONSERVING IMPLICIT VOLUME PENALTY METHOD FOR MOVING-BODY FLOWS

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Many engineering applications involve fluid flows around moving complex solid geometries such as wind turbines and turbo-machinery. A novel Immersed Boundary method [1] has been developed for such flows, coupling i) a Lagrangian Volume-of-Solid (VOS) description of the body avoiding mass and momentum conservation issues and ii) a robust implicit volume penalty forcing [2] embedded in a low-Mach number projection method to account for the solid's impact on the fluid dynamics.

Incorporating the VOS approach directly into the governing equations results in extra source terms in the mass and momentum equations. These terms represent the internal mass effect of a moving object as discussed in [3], leading to a trivial yet accurate computation of the forces exerted on the solid by the fluid.

The accuracy of the method has been assessed on several academic cases, involving stationary and/or moving bodies and with different mesh resolutions. The predicted forces on the solid are in excellent agreement with body-fitted reference cases. The system of equations is also proven to be fully mass conservative, independently of the mesh resolution used. Future work will focus on the method's application to real-world configurations.

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