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Numerical investigation of the 3D flow field generated by a self-propelling manta ray[1] JEAN-NOEL PEDERZANI, HOSSEIN HAJ-HARIRI, University of Virginia, UNIVERSITY OF VIRGINIA TEAM — A mixed Lagrangian-Eulerian approach is used to solve the three dimensional Navier-Stokes equation around a self-propelling manta ray. The motion of the manta ray is prescribed using a kinematic model fitted to actual biological data. The dependence of thrust production mechanism on Strouhal and Reynolds numbers is investigated. The vortex core structures are accurately plotted using the λ_2 criteria; and a correlation between wake structures and propulsive performance is established. This insight is critical in understanding the key flow features that a bio-inspired autonomous vehicle should reproduce in order to swim efficiently. The solution method is implemented on a block-structured Cartesian grid using a volume of fluid approach. To enhance the computational efficiency, a parallel adaptive mesh refinement technique is used. The present method is validated for the flow around a sphere. A basic station keeping control problem for a pitching and lagging wing is also analyzed to show the capability of the code to aid in controller design and stability analysis.

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