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An efficient algorithm for fully resolved simulation of freely swimming bodies ANUP SHIRGAONKAR, NEELESH PATANKAR, MALCOLM MACIVER, Department of Mechanical Engineering, Northwestern University — There is a need to better understand the physical principles underlying the extraordinary mobility of swimming and flying animals. To that end, we present a fully resolved simulation scheme for aquatic locomotion that is sufficiently general to potentially function for small flying animals as well. The method combines the rigid particulate scheme of Patankar et al. (IJMF, 2001) with a momentum redistribution scheme to consistently solve for fluid-body forces as well as the swimming velocity. The input to the algorithm is the deforming motion of the fish body or its fins in the frame of reference of the fish. The method is designed to be efficient, parallelizable, and can be easily implemented into existing fluid dynamics codes. We demonstrate that the new method is capable of simulating variety of fish forms including flexible bodies such as an eel, or bodies with flexible fins attached to them such as the black-ghost knifefish (Apteronotus albifrons). Insights into the hydrodynamics of aquatic locomotion based on our simulations will be summarized. The proposed technique is also applicable to variety of problems such as designing underwater vehicles, neuromechanical modeling, understanding the role of hydrodynamics on the evolution of fish forms, and animation.

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