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Numerical simulations of flying and swimming of biological systems with the viscous vortex particle method JEFF ELDREDGE, University of California, Los Angeles — Many biological mechanisms of locomotion involve the interaction of a fluid with a deformable surface undergoing large unsteady motion. Analysis of such problems poses a significant challenge to conventional grid-based computational approaches. Particularly in the moderate Reynolds number regime where many insects and fish function, viscous and inertial processes are both important, and vorticity serves a crucial role. In this work, the viscous vortex particle method is shown to provide an efficient, intuitive simulation approach for investigation of these biological systems. In contrast with a grid-based approach, the method solves the Navier–Stokes equations by tracking computational particles that carry smooth blobs of vorticity and exchange strength with one another to account for viscous diffusion. Thus, computational resources are focused on the physically relevant features of the flow, and there is no need for artificial boundary conditions. Building from previously-developed techniques for the creation of vorticity to enforce no-throughflow and no-slip conditions, the present method is extended to problems of coupled fluid–body dynamics by enforcement of global conservation of momenta. The application to several two-dimensional model problems is demonstrated, including single and multiple flapping wings and free swimming of a three-linkage fish.

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