Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

A viscous vortex particle method for deforming bodies, with application to biolocomotion J. ZHANG, J. ELDREDGE, UCLA — Bio-inspired mechanics of locomotion generally consist of the interaction of flexible structures with the surrounding fluid to generate propulsive forces. These mechanics have attracted new interest in recent years, particularly as candidates for novel autonomous vehicles. Hence, accurate numerical simulation tools are needed to explore such interactions in detail. In this work, we extend a viscous vortex particle method (VVPM) to continuously deforming two-dimensional bodies. The VVPM is a high-fidelity Navier-Stokes computational method which captures the fluid motion through evolution of vorticity-bearing computational particles. The kinematics of the deforming body surface are accounted for via a surface integral in the Biot-Savart velocity. The spurious slip in each time step is removed by computing an equivalent vortex sheet and allowing it to flux to adjacent particles. Particles of both uniform and variable size are utilized, and their relative merits considered. The placement of this method in the larger class of immersed boundary methods is explored. For validation purposes, we investigate a periodically deforming circular cylinder immersed in a stagnant fluid, for which an analytical solution can be derived when the deformations are small. We show that the computed vorticity and velocity of this motion are both in excellent agreement with the analytical solution. Finally, we explore the fluid dynamics of a simple fish undergoing undulatory motion in its backbone, to demonstrate the application of the method to biomorphic locomotion investigations.

Jeany Zhang
UCLA Mechanical & Aerospace Engineering

Date submitted: 02 Aug 2007 Electronic form version 1.4