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Towards direct numerical simulation of freely swimming fish. OSCAR CURET, NEELESH PATANKAR, MALCOLM MACIVER, Department of Mechanical Engineering, Northwestern University — Swimming mechanisms employed by fish are currently inspiring unique underwater vehicles and robotic devices as well as basic science research into the neural control of movement. Key engineering issues include propulsion efficiency, precise motion control and maneuverability. A numerical scheme that simulates the motion of freely swimming fish will be a valuable design and research tool. We are working towards this goal. In particular we are interested in simulating the motion of a gymnotiform fish that swims by producing undulations of a ventral ribbon fin while keeping its body rigid. We model the fish as a rigid body with an attached undulating membrane. In our numerical scheme the key idea is to assume that the entire fluid-fish domain is a fluid. Then we impose two constraints: the first requires that the fluid in the region occupied by the fish body moves rigidly (a fictitious domain approach), and the second requires that the fluid at the location of the fin has the traveling wave velocity of the fin (an immersed boundary approach). Given the traveling wave form of the fin, the objective is for the numerical scheme to give the swimming velocity of the fish by solving the coupled fluid-fish problem. We will present results for the forces generated by a fin attached to a fixed body and preliminary results for freely swimming fish.

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