Reference Map Technique for Incompressible Fluid–Structure Interaction

Supplemental movie descriptions

Movie 1

Simulation of a flexible seven-pointed rotor being spun with an oscillatory motion in a fluid. The colors show vorticity. The thick black line marks the fluid–structure interface. The thin black lines are contours of the components of the reference map and indicate how the rotor has deformed. The thin blue line shows the anchored region that rotates. The black dots are tracers in the fluid. Simulation parameters are $(\rho_f, \mu_f, \rho_s, G) = (1, 0.001, 3, 24)$.

Movie 2

Simulation of a thin flexible flag anchored at $(0, 0)$ in a fluid with mean velocity $(1, 0)$. The colors show vorticity. The flag has an aspect ratio of 20. The thick black line marks the fluid–structure interface. The thin black lines are contours of the components of the reference map and indicate how the flag has deformed. The black dots are tracers in the fluid. Simulation parameters are $(\mu_f, K_B, Re) = (0.32, 0.001, 3000)$.

Movie 3

Simulation of a thick flexible flag anchored at $(0, 0)$ in a fluid with mean velocity $(1, 0)$. The colors show vorticity. The flag has an aspect ratio of 5. The thick black line marks the fluid–structure interface. The thin black lines are contours of the components of the reference map and indicate how the flag has deformed. The black dots are tracers in the fluid. Simulation parameters are $(\mu_f, K_B, Re) = (0.04, 0.004, 750)$.

Movie 4

Simulation of a thick flexible flag anchored at $(0, 0)$ in a fluid with mean velocity $(1, 0)$. The colors show vorticity. The flag has an aspect ratio of 5. The thick black line marks the fluid–structure interface. The thin black lines are contours of the components of the reference map and indicate how the flag has deformed. The black dots are tracers in the fluid. Simulation parameters are $(\mu_f, K_B, Re) = (0.28, 0.004, 750)$.

Movie 5

Simulation of a flapping swimmer in a fluid. The colors show vorticity. A subregion within the solid body is actuated to bend periodically and the remaining solid is passive. The

motion induces the flapping body to swim. The thick black line marks the fluid–structure interface. The thin black lines are contours of the components of the reference map and indicate how the swimmer has deformed. The black dots are tracers in the fluid. Simulation parameters are $(\rho_f, \mu_f, \rho_s, G) = (1, 0.0005, 4, 10)$.

Movie 6

Simulation of 42 squares sedimenting in a fluid-filled box. The colors show vorticity. The thick black lines mark the fluid–structure interfaces. The thin black lines are contours of the components of the reference map and indicate how the squares deform. The black dots are tracers in the fluid. Simulation parameters are $(\rho_f, \mu_f, \rho_s, G, g) = (1, 0.001, 3, 2, 1.5)$.

Movie 7

Simulation of 75 flexible rods of variable density rearranging in a fluid-filled box. The colors show density. The thick black lines mark the fluid–structure interfaces. The black dots are tracers in the fluid. Each rod density ρ_s is randomly chosen over the range 0.4 to 1.6. Simulation parameters are $(\rho_f, \mu_f, G, g) = (1, 0.002, 1.3, 1)$.

Movie 8

Simulation of 75 flexible rods of variable density rearranging in a fluid-filled box. The colors show the pressure deviation, $p' = p + \rho_f g y$. The thick black lines mark the fluid–structure interfaces. The black dots are tracers in the fluid. Each rod density ρ_s is randomly chosen over the range 0.4 to 1.6. Simulation parameters are $(\rho_f, \mu_f, G, g) = (1, 0.002, 1.3, 1)$.

Movie 9

Simulation of 75 flexible rods of variable density rearranging in a fluid-filled box. The colors show vorticity. The thick black lines mark the fluid–structure interface. The black dots are tracers in the fluid. Each rod density ρ_s is randomly chosen over the range 0.4 to 1.6. Simulation parameters are $(\rho_f, \mu_f, G, g) = (1, 0.002, 1.3, 1)$.