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Design optimization of a drag-based vibratory swimmer using averaging SEVAK TAHMASIAN, ANNE STAPLES, Virginia Tech — Many aquatic animals and organisms use periodic motions of their body or limbs to generate forward motion. Using averaging techniques and experiments, we investigate the dynamics and design optimization of a class of vibratory swimmers which use asymmetric drag to achieve aquatic locomotion. The equation of motion of the system is a time-periodic, piecewise-smooth differential equation. Dynamic analysis of this class of systems shows that the maximum mean forward speed is achieved by minimizing the ratio of the drag coefficients in the forward and backward phases of motion. Though the drag can be a quadratic, linear, or other function of velocity, our results show that the optimum design is independent of this function. The analysis is also expanded to include the effects of the fluid added mass on the dynamics and design optimization of the class of vibratory systems. Using a centimeter-scale surface vessel with an oscillatory mass inside and an asymmetric rigid fin immersed in fluid, we verified the theoretical optimization results experimentally. The analysis presented here can aid in the design and optimization of bio-inspired and biomimetic robotic swimmers..

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