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Three-link Swimming in Sand R.L. HATTON, Carnegie Mellon University, YANG DING, ANDREW MASSE, Georgia Institute of Technology, HOWIE CHOSET, CMU, DANIEL GOLDMAN, Georgia Tech — Many animals move within in granular media such as desert sand. Recent biological experiments have revealed that the sandfish lizard uses an undulatory gait to swim within sand. Models reveal that swimming occurs in a frictional fluid in which inertial effects are small and kinematics dominate. To understand the fundamental mechanics of swimming in granular media (GM), we examine a model system that has been well-studied in Newtonian fluids: the three-link swimmer. We create a physical model driven by two servo-motors, and a discrete element simulation of the swimmer. To predict optimal gaits we use a recent geometric mechanics theory combined with empirically determined resistive force laws for GM. We develop a kinematic relationship between the swimmer's shape and position velocities and construct connection vector field and constraint curvature function visualizations of the system dynamics. From these we predict optimal gaits for forward, lateral and rotational motion. Experiment and simulation are in accord with the theoretical predictions; thus geometric tools can be used to study locomotion in GM.

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