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Optimal Navigation of Self-Propelled Colloids in Microstructured Mazes YUGUANG YANG, MICHAEL BEVAN, Johns Hopkins University — Controlling navigation of self-propelled microscopic 'robots' subject to random Brownian motion in complex microstructured environments (e.g., porous media, tumor vasculature) is important to many emerging applications (e.g., enhanced oil recovery, drug delivery). In this work, we design an optimal feedback policy to navigate an active self-propelled colloidal rod in complex mazes with various obstacle types. Actuation of the rods is modelled based on a light-controlled osmotic flow mechanism, which produces different propulsion velocities along the rod's long axis. Actuator-parameterized Langevin equations, with soft rod-obstacle repulsive interactions, are developed to describe the system dynamics. A Markov decision process (MDP) framework is used for optimal policy calculations with design goals of colloidal rods reaching target end points in minimum time. Simulations show that optimal MDP-based policies are able to control rod trajectories to reach target regions order-of-magnitudes faster than uncontrolled rods, which diverges as maze complexity increases. An efficient multi-graph based implementation for MDP is also presented, which scales linearly with the maze dimension.

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