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Modeling and Experiments with a High-Performance Flexible Swimming Robot[1] ALEXANDER WIENS, ANETTE HOSOI, MIT — Conventionally, fish-like swimming robots consist of a chain of rigid links connected by a series of rigid actuators. Devices of this nature have demonstrated impressive speeds and maneuverability, but from a practical perspective, their mechanical complexity makes them expensive to build and prone to failure. To address this problem, we present an alternative design approach which employs a single actuator to generate undulatory waves along a passive flexible structure. Through simulations and experiments we find that our robot can match the speed and agility of its rigid counterparts, while being simple, robust, and significantly less expensive. Physically, our robot consists of a small ellipsoidal head connected to a long flexible beam. Actuation is provided by a motor-driven flywheel within the head, which oscillates to produce a periodic torque. This torque propagates along the beam to generate an undulatory wave and propel the robot forwards. We construct a numerical model of the system using Lighthill's large-amplitude elongated-body theory coupled with a nonlinear model of elastic beam deformation. We then use this simulation to optimize the velocity and efficiency of the robot. The optimized design is validated through experiments with a prototype device.

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