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CFD-Based Multi-Objective Controller Optimization for Soft Robotic Fish with Muscle-like Actuation ANDREW HESS, XIAOBO TAN, TONG GAO, Michigan State University — Soft robots take advantage of rich nonlinear dynamics and large degrees of freedom to perform actions by novel means beyond the capability of conventional rigid robots. Nevertheless, there have been considerable challenges in analysis, design, and optimization of soft robots due to their complex behaviors. This is especially true for underwater soft robotic swimmers whose dynamics are determined by highly nonlinear fluid-structure interactions. We present a holistic computation framework that employs a multi-objective evolutionary method to optimize feedback-based controllers of a soft robotic fish prototype subjected to artificial muscle actuation. The resultant nonlinear fluid-structure interactions are fully solved by using a novel fictitious domain/active strain method. Compared to the conventional approaches that specify the entire-body curvature variation, we demonstrate that imposing contractile active strains locally can produce various swimming gaits using far fewer control parameters. It also facilitates feed-back controller design for muscle actuation schemes using high-fidelity CFD simulation data. We optimize the controller coefficients via several "thought" experiments where we seek optimal swimming performances of the robotic fish tracking moving targets.

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