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A Biomimetic Propulsor for Active Noise Control: Theory and Experiments

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The application of biology-based understanding to the alteration of radiated noise in underwater propulsors using active control is considered. By introducing artificial muscles at the trailing edge of an upstream stator blade, and articulating them like a fish tail, the goal is to alter the wake momentum and therefore the resulting radiated noise of a downstream rotor. The tail oscillations of an unsteady stator blade are altered using unsteady lift measurements at the propulsor rotor blade. The effect of using such a biomimetic actuator on the radiated noise is investigated. The approach used is to derive an analytical model that describes the effect of the oscillation of the artificial muscles on the unsteady forces acting on the rotor and therefore on the direct radiation component of the noise. This model in turn is used to generate a prescriptive active control strategy based on dynamic inversion that directs how the muscles must be articulated in order to achieve a desired noise spectrum. The approach adopted can be viewed as the realization of "virtual" blades with different sweep and noise characteristics. The work provides an understanding of the effect of non-uniform wakes on radiated noise and can lead to a general approach by which wakes can be altered.