Flow Sensing and Feedback Control of a Fish-inspired Underwater Vehicle

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Motivation

- Bio-inspired robots for highly efficient & maneuverable underwater vehicles
- Lateral-line system, a sensing organ in fish, to detect surrounding flow with distributed neuromasts
- Challenges in navigating in murky and unknown underwater environments

Flow Sensing

- Artificial lateral line made using Ionic Polymer Metal Composites (IPMCs)

Behavioral capabilities: rheotaxis, station-holding, and speed control
- Potential-flow model for a Joukowski-shaped fish robot with discrete-time vortex shedding

Flow estimation using a Bayesian filter for distributed pressure measurement
posterior = likelihood x prior

Feedback Control

- Closed-loop control strategy using a feedforward controller based on averaged model and a feedback controller using estimated flow

Experiments

- Flexible fish robot fabricated using a 3D printed mold and silicone rubber material

Future research

- Momentum control using reaction wheel actuation for flexible fish robots to achieve maneuverability
- Higher degree-of-freedom dynamics and closed-loop control of path following in neutral buoyancy research facility using underwater mo-cap
- Coordination of fish robots for energy harvesting in schooling with flow sensing capability

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